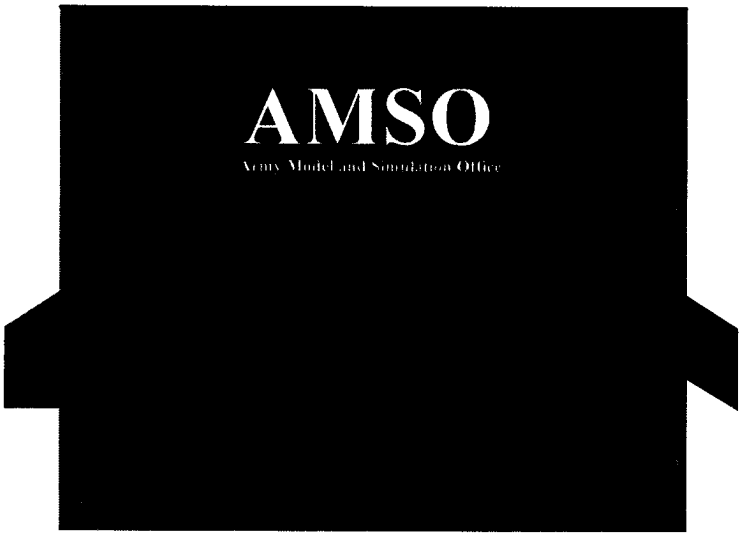

Army Model and Simulation Stewardship Report FY98

Office of the Deputy Under Secretary of the Army
(Operations Research)
Army Model and Simulation Office

October 1998

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS
400 ARMY PENTAGON
WASHINGTON DC 20310-0400

REPLY TO
ATTENTION OF:

DAMO-ZS (70-16a) 29 September 1998

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: FY98 Army Model Improvement Program (AMIP) and Simulation Technology (SIMTECH) Program Stewardship Report

1. This memorandum distributes the FY98 Army Model Improvement Program (AMIP) and Simulation Technology (SIMTECH) Program Stewardship Report. The Stewardship Report provides the status of the FY98 funded AMIP and SIMTECH projects and the benefits that the Army realized from them.

2. The Management Decision Package (MDEP) MS4D distributes the funds for the AMIP and SIMTECH projects. The AMIP directly support the technical Model and Simulation (M&S) standards development goals of the Army. Each fiscal year, the Army's Standards Category Coordinators nominate M&S projects that will further their standards category's standards development objectives. The SIMTECH Program focuses on accelerating the development of emerging technologies that show promise for improving the art and science of modeling and simulation (M&S). This program also seeks to develop technologies that show potential for support the Army's M&S standards development objectives.

3. The AMSO POC is LTC Don Timian, (703) 601-0012/13, extension 32 (DSN 329),e-mail: timiadh@hqda.army.mil.

Enclosure
as

VERON M. BETTENCOURT JR.
U.S. Army, SES
Director, Army Model and
Simulation Office

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE**: Calibration of the DELPHI Target Acquisition Model

2. **PROJECT ID**: AMIP-98-ACQ-01

3. **SPONSORING AGENCY**: TRADOC Analysis Center – White Sands Missile Range

4. **ACCOMPLISHMENTS**: The objective of the project was to identify and calibrate replacement algorithms for the proprietary algorithms in the original ORACLE vision model. The ORACLE vision model represents the eye's performance with two sets of algorithms. One set of algorithms represents foveal vision channel, the second set of algorithms represents the peripheral vision channel. Direct open literature replacement algorithms have been identified for the foveal channel algorithms. No direct replacements for the peripheral channel algorithms have been identified. A functional replacement for the peripheral channel algorithms from the US MICOM VISPOE model provides a numerically similar representation which is nonproprietary. Calibration data sources selection and calibration of both sets of algorithms are currently underway.

   An exploration of HLA compliance issues for Delphi has led to the development of a draft SOM for class sensor which will be forwarded to the Object Management Standard Category for completion. This SOM will serve as the prototype for future sensor categories (radar, acoustic, etc.).

5. **LESSONS LEARNED:** To Date, there have been no significant lessons learned.

6. **BENEFITS TO ARMY**: Use of the DELPHI algorithms will improve the representation of target acquisition in combat simulations such as CASTFOREM, Janus, SAFs, and future system resolution simulations. This project will have developed techniques for assessing the suitability of DELPHI calibrations. These techniques can be applied to future data sets and other perception models to assess the appropriateness of the current calibration to represent additional situations.

7. **WORK REMAINING TO BE COMPLETED**: Four tasks remain to be completed: Calibration of the foveal and peripheral algorithms against laboratory and field experiment data; C++ code development of the calibrated algorithms and testing in code in a stand alone mode and combat simulation application; draft of the Proposed standard and submission to the Standards Nomination and Approval Process; preparation and submission of the final draft of the SOM for sensors to the Object Management Standards Category.

8. **SCHEDULE WITH MILESTONES**: Complete funding for this project ws not received until 4Q FY98. Therefore, some of the work originaly scheduled for completion in FY98 has been slipped to FY99. Calibration of the algorithms against laboratory and field experiment data (4Q FY98). C++ code development of the algorithms and testing in code in standalone and combat simulation application (2Q FY99). Draft of the Proposed Standard and submission to the standards review and approval process (3Q FY99). Preparation and

submission of the final draft of the SOM for sensors to the Objects Standard Category (3Q FY98).

9. **POINT OF CONTACT**:

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE**: Using the High Level Architecture (HLA) Object Model Template (OMT) for Simulation Specification

2. **PROJECT ID**: AMIP-98-ARCH-01

3. **SPONSORING AGENCY**: STRICOM

4. **ACCOMPLISHMENTS**: The intent of the proposed project was to develop extensions to the HLA OMT that would enable its use as a method for simulation specification and design. The goal was to use the OMT "before-the-fact" during the simulation specification and design process. The University of Central Floridia, Insitute for Simulation & Training contractor experienced difficulty identifying personnel to complete the effort, therefore the project was canceled and the money was returned to the Army Model & Simulation Office (AMSO).

5. **LESSONS LEARNED:** N/A

6. **BENEFITS TO ARMY**: N/A

7. **WORK REMAINING TO BE COMPLETED**: N/A

8. **SCHEDULE WITH MILESTONES**: N/A

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE**: Communication Data Generation

2. **PROJECT ID:** AMIP-98-C3-01

3. **SPONSORING AGENCY:**
   (a) U.S.A. Signal Center (Mr. B. Kunkel)
   (b) TRADOC Analysis Command (TRAC) (Mr. Tim Bailey)
   (c) Communications Electronics Command (CECOM) (Mr. Chandu Sheth)

4. **ACCOMPLISHMENTS:** TRAC provided the type messages to be transmitted by the communications system to be portrayed in the model. SIGCEN working with TRAC has begun the identification of the specific message traffic contained in the C4RDP. This will allow determination of the OPFAC which supports equipment authorizations. CECOM is currently developing an OPNET module of a generic radio, which will allow the maximum of parameters to be varied, thus enabling it to represent conceptual equipment.

5. **LESSONS LEARNED:** Data bases contain a plethora of information, but there is no standard methodology to insure a cross check/ search can be accomplished between various systems. Obtaining the information is currently a manual effort. Development of OPNET modules is resource intensive, but once finished it will provide a reusable product that can be set up in a short period of time.

6. **BENEFITS TO THE ARMY:** Once the traffic load is established it will be able to be employed for subsequent model efforts. This will reduce the time it takes to set up an experiment, and subsequently reduce the turn around time to provide answers. Development of a generic radio module will allow modeling of future equipment, which is in the concept stage, without waiting for engineering specifications. This will also allow testing the effects of various equipment functions before the finalization of the RFP. Knowing the result of the different factors on the operation of the radio will permit a priority listing for use in cost reduction.

7. **WORK REMAINING TO BE COMPLETED:** CECOM completion of the generic radio model. SIGCEN and TRAC completion of the traffic identification and linkage with the C4RDP database.

8. **SCHEDULE:** Completion of traffic identification and the radio module, as well as entering the Generic Radio Model into SNAP is expected to be done by the first quarter of FY99. All effort beyond the end of FY98 will be borne by the participants with existing resources. Work load verses short resources has slowed the ability to complete this project within the calendar year. In addition, the funding was not available at the start of the FY.

FY98 AMIP PROJECT STATUS REPORT

9. **POINTS OF CONTACT:**

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE**: Command Planning Process Standard

2. **PROJECT ID**: AMIP-98-CDM-01

3. **SPONSORING AGENCY**: National Simulation Center, TRADOC

4. **ACCOMPLISHMENTS**: The aim of this project is to examine the reuse of an existing artificial intelligence planning system (Adversarial Planner) as one means of automating command decision making at a level adequate to eliminate lower echelon simulation role players. Command Entities in WARSIM 2000 must emphasize planning and deciding how to accomplish stated and implied goals communicated in operations orders. We chose Adversarial Planner (AP) as the existing planning system to reuse in this effort. Reusing this task decomposition planning system helped to test the hypothesis that mid-echelon planning and monitoring cognitive activities can be simulated adequately to meet training requirements of a system such as WARSIM 2000.

   AP's capabilities include:

   - Generating coordinated actions (plans) for each resolution unit (subordinate) based on orders from higher.
   - Monitoring plan execution based on situation and spot reports from subordinates.
   - Re-planning when execution deviates from the plan or when a new order is received from higher.

   AP uses task decomposition planning to generate subordinate plans from higher headquarter's orders. Briefly, task composition begins when a user (possibly in the form of an order) specifies a goal—a state-based description of a task to be accomplished. The planning algorithm uses application-specific templates called "operators" to decompose the goal into more concrete subgoals, eventually bottoming out in actions that the subordinate agents (units) are able to execute (possibly by further task decomposition).

   For any goal or subgoal, there generally will be several templates that can be expanded to fulfill it. (If there were always only one "script" to fulfill a subgoal then the problem would be one of control, not planning). AP uses decision analysis to choose which operation can fulfill a given subgoal. Therefore, AP is based on a normative model of planning, rather than a descriptive cognitive model. The user can however, bias the utility function to favor certain types of operations over others to reflect, say, aggressive or conservative command style.

   AP extends the classical task decomposition framework to include multi-agent coordination. That is, it plans organized actions for multiple subordinate agents to accomplish subgoals. This means that a primary concern is reasoning about how to coordinate actions in time. Using an example of an envelopment to defeat an enemy, the planner would determine the number of units attacking and where and *when* they must start the implied subtasks. In this

example, the attacks must start simultaneously, or a unit that begins too early may take heavy casualties. Multi-agent coordination is one of the capabilities that led us to select AP as a possible model of command decision making in WARSIM 2000.

Another important characteristic of command staff planning is reasoning about potential reactions of the enemy and augmenting the plan with counteractions to foil these reactions. AP implements an action-reaction-counteraction cycle modeled on course of action development doctrine outlined in Army Field Manual 101-5: Staff Organizations and Operations.

Because of the adversarial nature of the ground maneuver domain, a primary function of a command entity is to monitor execution and replan when, not if, the unfolding battle deviates from the current plan's projections. AP uses the plan structure to monitor execution and replan. AP continually compares anticipated states of the world with the perceived situation, constructed by processing situation and spot reports from subordinates. When the perceived situation deviates from the predicted state enough that it is clear the plan will fail, replanning modifies the current plan and causes revised orders to be transmitted to subordinates. AP's replanning strategy is to maintain as much of the plan as possible, only replacing subplans that are crucial to success.

We were successful in rehosting and reimplementing the AP software independent of the Eagle simulation on a Windows NT workstation. The AP software was then connected to the WARSIM 2000 Testbed prototype at STRICOM.

Now that AP has been independently implemented, we are examining how to integrate the software into the NSC's Military Art of Command Environment simulation in which we are using a multi-paradigm approach to address Command Decision Modeling research issues.

In addition to the rehosting effort, we are currently examining the planning process documented by the Army's Operational Architecture and the dynamic model we developed as a means of incorporating AP technology. This effort is in collaboration with TPIO-ABCS.

5. **LESSONS LEARNED:** AP imposes little overhead on the testbed. Planning for five subordinate units takes less than five seconds on a 300 Mhz Pentium II NT with 128MB RAM. However, our prototype is in an early state. As we add terrain reasoning, complex representations of the battlefield operational systems, and cognitive biases due to perceived truth, processing requirements will increase. Because we run AP in a separate process, performance issues, should they arise, can be addressed with a faster machine by multi-processing. This may be necessary as we start running several copies of AP, one for each command being simulated.

6. **BENEFITS TO ARMY**: The WARSIM 2000 program is considering several methods for implementing cognitive behaviors associated with course of action planning and execution control. The planning prototype based on previous AP work accomplishes many of the

primary requirements of a generative planning capability for WARSIM 2000, and will serve as a baseline for comparison to other behavior modeling methods not yet examined.

The effort to migrate AP technology to a Windows NT environment using common LISP, makes the product more reusable by other efforts and proves that it can be re-implemented to support other simulation environments.

The final result of the benefits of this investigation will be seen when other methods are implemented within the testbed environment and we are better able to assess the benefits and issues associated with a multi-paradigm approach to command decision modeling.

7. **WORK REMAINING TO BE COMPLETED:** We have completed the first prototype and have produced a users guide for AP technology that resides on the CDM website. Our next efforts will be to take the more general common LISP AP and rehost the software in our G2 based Military Art of Command Environment (MACE).

8. **SCHEDULE WITH MILESTONES**: The software effort has been completed. A user's guide has been published. We now will develop a normative standard that we can place in SNAP and ASTARS for the M&S community to reference and expect to complete this work by November 1998. We hope to continue the rehosting effort as a part of our collaborative Command Decision Modeling work with the United Kingdom in FY99. Our collaborative work will make use of the command agent architecture which was developed during the DUSA (OR) sponsored 2d US/UK CDM Workshop and which will be expanded upon at the upcoming 3rd US/UK Workshop, 27 July 1998 to 4 August 1998.

9. **POINT OF CONTACT**:

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE**: Battle Management Language and Knowledge Representation Standard

2. **PROJECT ID**: AMIP-98-CDM-02

3. **SPONSORING AGENCY**: National Simulation Center, TRADOC

4. **ACCOMPLISHMENTS**: The intent of this effort was to develop a common vocabulary to represent the command and control decision-making process in modeling and simulation software. Analysis of various existing vocabularies is still ongoing at this stage. We have looked at the Command and Control Simulation Interface Language (CCSIL), the Eagle model's Battle Management Language (BML) and DARPA's Knowledge Query and Manipulation Language (KQML). We have also carefully studied the TPIO-ABCS developed Army Operational Architecture (OA) and the development language of an object oriented systems processing software called G2.

   Our analysis and prototyping efforts thus far reveal that the various languages associated with current simulations are parochial in code and development to that simulation with varying degrees of detail and complexity. The OA provides a detailed and vigorous description of information flow for all staff processes. The G2 model and its easy to use developmental language combined with the OA allows an innovative approach to a battle management language development by modeling this complex subject graphically as objects. Though novel, this approach as a standard would be revolutionary rather than evolutionary.

   Our current approach is two-phased. We will attempt to develop a standard that supports current as well as future simulations based on the languages we have reviewed. We will also continue to investigate developing the language standard in an object-oriented environment. We are currently planning to finish a quality product which we can place in SNAP and ASTARS by 30 September 1998.

5. **LESSONS LEARNED:**
   - Approaching the problem using the OA modeled by G2 provides a rich language and a dynamic means to study and analyze effects of resource, time or inputs in the decision making process.
   - Using the rapid prototyping capability of G2, we can develop new more flexible language at a much faster pace.
   - Using the TPIO-ABCS OA as a language basis takes an advantage of a validated TRADOC product describing information processes across all echelons of battle staff decision-making processes.
   - Reviewing the OA from the simulation language point-of-view provides the opportunity to give feedback to TPIO-ABCS on the consistency of their doctrinal language.

FY98 AMIP PROJECT STATUS REPORT

6. **BENEFITS TO ARMY**:
   - A standard Battlefield Management Language would reduce the cost of developing new models and simulations.
   - A standard language would increase the efficiency of any development process because of the commonality of language and the ability to rapidly transmit and assimilate it.

7. **WORK REMAINING TO BE COMPLETED**: Produce a standardized Battle Management Language model and user's guide which provides operational data in a format such that a computer can reason on it . This will facilitate command and planning knowledge to feed decision support services used by multiple command agents.

8. **SCHEDULE WITH MILESTONES**: Battle Management Language model and user's guide by 30 September 1998.

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE**: Characteristics and Performance (C&P) Data Interchange Format (DIF) Development

2. **PROJECT ID**: AMIP-98-DATA-01

3. **SPONSORING AGENCY**: AMC, NGIC

4. **ACCOMPLISHMENTS**: Accomplishments to date include the following:

   a. Development of roadmap for standardization of characteristics and performance data.

   The roadmap serves as a benchmark for how standardization of the C&P data areas will be standardized. The roadmap sets for the process for mapping the data elements of AMSAA and NGIC C&P databases.

   b. Development of consolidated data model for C&P data for mine systems.

   Completed data modeling of AMSAA and NGIC C&P data elements in this area. Conducted preliminary review to ascertain mapping functions and potential conflicts. Meeting for 19 August 1998 set to finalize the data model and mapping functions. At this time, tentative mappings of TRAC-FLVN data elements to the standard model will be developed.

   c. Development of consolidated data model for C&P data for air defense.

   Completed data modeling of AMSAA and NGIC C&P data elements in this area. Conducted preliminary review to ascertain mapping functions and potential conflicts. Meeting for 19 August 1998 set to finalize the data model and mapping functions. At this time, tentative mappings of TRAC-FLVN data elements to the standard model will be developed.

   d. Development of consolidated data models for C&P data for Armor and Infantry Systems.

   NGIC completed data model for their representation of Infantry and Armor systems C&P data. AMSAA effort is ongoing with an expected completion data of 30 August 1998 for Armor and 20 September 1998 for Infantry. Mapping of data elements between NGIC and AMSAA will occur in late September 1998.

   e. Development of consolidated data models for C&P data for Aviation, Artillery and Sensor Systems.

   NGIC will complete data modeling of these areas by mid-September 1998. AMSAA has let a contract to complete data modeling of these areas by mid-October 1998. Mapping functions will be developed between October and November 98.

f. Submission of data models as standards.

Data models will be submitted as standards as they are completed. They will first be submitted to SNAP for Army comments and then after approval will be submitted to DoD for inclusion in the DoD data dictionary. All areas will be submitted into SNAP as part of this effort by the end of January 1999.

5. **LESSONS LEARNED:** Differing levels of fidelity in data models require additional work prior to development of mapping functions. Any levels that cannot be resolved will require aggregation techniques to reformat the data. The standard data model should be at the highest level of resolution of the merged models.

6. **BENEFITS TO ARMY**: The data models will serve as guidelines for development of software to automate the transfer of data between organizations. They will also serve as a blueprint for future database and standard algorithm construction.

7. **WORK REMAINING TO BE COMPLETED**: Remaining work under the scope of this task proposal includes completion of data models as identified above and submission of standards. Since this is really a joint AMIP and Army analytical community project, much additional work is required. The additional work includes mapping CAA and TRAC data models to the standard and the actual development of the interchange software. Full completion of all phases will take approximately 2 to 3 years.

8. **SCHEDULE WITH MILESTONES:**

Product	Planned Date	Actual Date	Comments
Source Lists	Dec 97	Dec 97	
Plan of Attack	Feb 98	Jan 98	
SAI Models	May 98	Aug 98 - Oct 98	Completed in phases.
Mapping Functions	Aug 98	Aug 98 – Nov 98	Completed in phases.
SNAP Submissions	Sep 98	Dec 98	Individual reports rather than one final report.

9. **POINT OF CONTACT**:

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE:** Development of an Extensible Hierarchy and Object Representation for Deployment Models and Simulations.

2. **PROJECT ID:** AMIP-98-DEP-01

3. **SPONSORING AGENCY:** Military Traffic Management Command Transportation Engineering Agency (MTMCTEA)

4. **ACCOMPLISHMENTS:** Partial funding ($68K) for this effort did not arrive at the contractor until after March 1998. Full funding still has not been received. To date, MTMCTEA and Argonne National Lab (ANL) have joined the transport-oriented class hierarchies from the Port Simulation (PORTSIM) and Transportation Systems Capability (TRANSCAP) models and have begun considering how they should be altered for the pending Coastal Inter-Modal Transport Model (CITM). A draft report, explaining the elements of which this joint hierarchy are composed and the reasons for assembling it in that fashion, is nearing completion.

5. **LESSONS LEARNED:** Because of the late start time of this project, there have been no significant lessons learned at this time.

6. **BENEFITS TO THE ARMY:** This project supports Army efforts to pursue model and simulation interoperability and reusability. The primary benefit of this project is to reduce resources required to develop and maintain deployment models and simulations. Models and simulations are used to analyze, plan, train, and execute deployments. This project will develop standard and consistent object attribute representation and behavior for all deployment model and simulation applications that rely on an underlying object representation.

7. **WORK REMAINING TO BE COMPLETED:** The goals and objectives for this initial phase to standardize the code structures of discrete event, object-oriented, logistics simulations is to create, for transport-oriented objects (DoDX railcars, commercial transport assets, military vehicles): 1) Web-ready programmer documentation, 2) a Java class package, 3) a simple, strawman simulation example that uses the class package, and 4) a final report. Implementation of the class design in Java and the small sample program, along with finalizing the report, are still to be completed. In the remaining years of the project, we plan to produce similar joint hierarchies for the resource classes that act on the transportation assets (MHE, inspectors, and drivers) and the area classes where these actions are performed (motor pools, staging areas, and classification yards).

8. **SCHEDULE WITH MILESTONES:**

   1) Initial object design review. Completed – 3rd QTR FY98.
   2) Strawman Transportation Object Hierarchy – 4th QTR FY98
   3) Final Transportation Object Hierarchy and Source Code, plus entry into SNAP. Completed – 1st QTR FY99.

FY98 AMIP PROJECT STATUS REPORT

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE:** Modeling of the Ground State in Winter Environments (GSWE)

2. **PROJECT ID:** AMIP-98-DYN-01

3. **SPONSORING AGENCY:** Army Research Laboratory and US Army Corps of Engineers/Cold Regions Research Engineering Laboratory (CRREL)

4. **ACCOMPLISHMENTS:** It is a well-established fact that the state-of-the-ground is driven in a large part by the downwelling solar and infrared (IR) fluxes. Models developed to predict the state-of-the-ground for Army operations will depend critically on these fluxes for initialization. Unfortunately, these fluxes are not routinely measured parameters as is the case with more common meteorological parameters like temperature, relative humidity, etc. Therefore, indirect methods must be utilized to generate the required flux initialization information for state-of-the-ground models.

   CRREL has numerous winter data sets that can be used to initialize both SNTHERM and AIM. One of the more comprehensive data sets was collected during the winter at Grayling, MI, under the Joint Test and Evaluation's Smart Weapons Operability Enhancement program. These data sets also contain the information that can be used as ground truth for the evaluation of the predicted solar and IR fluxes and surface temperatures. Scenarios are also being run for the fall season to investigate the sensitivity of the surface temperature to flux initialization for non-winter environments.

   The solar and IR fluxes are being calculated using a semi-empirical scheme developed at CRREL based on the work of Shapiro, a plane parallel scheme using MODTRAN, and AIM. AIM uses the Cloud Scene Simulation Model (CSSM) in conjunction with the Boundary Layer Illumination and Transmission Simulation (BLITS) radiative transfer program to determine the spectral and spatial distribution of fluxes in cloudy and clear atmospheres. Unlike the first two approaches that are either a parameterization or assume a plane parallel atmosphere, BLITS uses a physics based approach that models 3D fluxes through dense clouds.

   Case studies for Grayling I, Yuma, and Grayling II have been selected and a database for the desired environmental conditions has been generated. In addition, land surface type digital maps have been prepared and albedo information for each of the land surface types has been generated. Digital copies of these databases have been sent to ARL. The CRREL semi-empirical solar and infrared (based on the work of Shapiro & Wachtmann) models have been modified to provide the desired output for initializing the thermal model. Work is in progress on generating statistics of the spatial variability of the total solar flux over the test regions selected for this effort. These statistics will be generated using both a spatial and temporal technique. The spatial technique involves determining the variability of the total solar flux based on measurements at several locations over the test region, while the temporal technique involves determining the variability of the total solar flux from a time series of measurement at a single location. The length of the time series is based on the wind speed at the cloud level. These statistics will be compared with similar statistics derived from the AIM

predicted distribution of total solar flux over the test region. ARL has modified AIM to accept 2 cm^{-1} resolution data. This data is then analyzed in a new routine which processes the illumination and extinction coefficient data to optimize the choice of bandwidth, mean wavenumber, mean layer transmission, and mean illumination for a series of correlated k-distribution calculations. The object is to divide the spectral data into categories of similar transmission and illumination characteristics rather than similar wavelength alone. This approach reduces the computational burden associated with integrating over a spectral interval. So, for example, all the low transmission regions within a wider band may be processed simultaneously and then all the high transmission regions processed in a second run. The method used to divide the individual 2 cm^{-1} bands into categories involves the computation of a 3D vector for each band. The vectors consist of an illumination dimension, a normalized wavenumber dimension which is also useful in characterizing aerosol and Rayleigh scattering characteristics, and a transmission dimension which measures the average layer transmission for that band. Each 'class' of data is characterized by the data elements included in the class. Means and standard deviations are computed for each class and the class with the largest variance in one of its dimensions is divided. This procedure is followed until a user-selected maximum number of calculation sets is reached. The resulting sets should be optimal for the number of calculations selected. This processing approach was integrated into the AIM front-end code and tested under an initial set of data conditions. In some cases the computations matched the data very well, but more tests will be required to determine whether the resulting code is producing realistic results under most conditions. In particular, the code will be tested next under clear sky conditions and compared with measured Grayling I data. This should indicate whether the input illumination information is realistic.

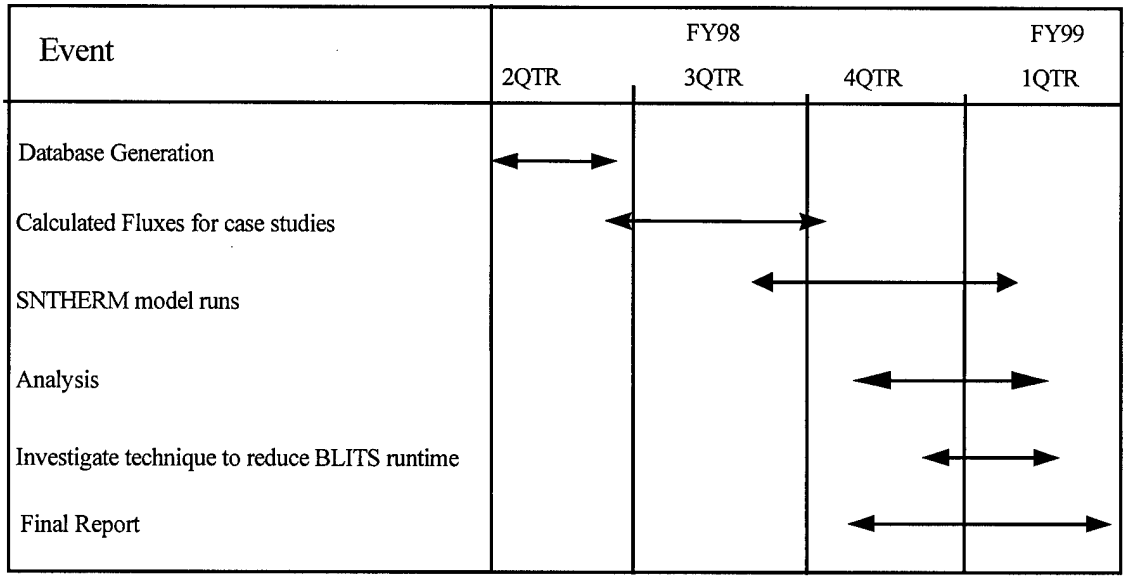
5. **LESSONS LEARNED:** In assessing surface illumination and loading conditions we found that the thickness of the boundary layer is a critical parameter. Normally the surface visibility is measured, as radiative transfer algorithms for determining the density of the haze directly require this parameter. However, the thickness of the boundary layer multiplied by the extinction coefficient determines the overall optical depth of the layer and this is a controlling parameter in the determination of the ratio of diffuse to direct radiation reaching the surface. This ratio should influence the degree of `clutter' produced in IR scenes because of self-shadowing of complex objects (trees, other vegetation, vehicles). Less direct radiation will permit more uniform illumination and less clutter. The boundary layer thickness should be derivable from rawinsonde upper air measurements. The information gleaned is that the thickness of the boundary layer, which contains most atmospheric aerosols, is extremely important for the calculation of surface flux.

6. **BENEFITS TO ARMY:** Cold environments can have drastic effects on Army operations. Current available Army models and simulations have almost no ability to replicate these effects. An inaccurate forecast, or no forecast at all, of the impact of cold environments on Army operations can have a negative effect on training, resulting in inaccurate planning, faulty analysis and subsequent failure of Army operations. The objective is to address the issue of predicting the state of the ground (surface temperature, snow cover, snowmelt, and freeze/thaw depths) by utilizing CRREL's SNTHERM energy balance model. The

methodology will investigate the sensitivity of the ground state to different flux model initializations, including a semi-empirical model, a plane parallel model, and ARL's AIM (Atmospheric Illumination Module). The effect of different solar and IR model fluxes in defining the state of the ground will be evaluated. This information will be of value in determining flux model fidelity necessary for high fidelity Synthetic Scene Generation Models.

7. **WORK REMAINING TO BE COMPLETED:** Work is in progress on generating statistics of the spatial variability of the total solar flux over the test regions selected for this effort. These statistics will be generated using both a spatial and temporal technique. The spatial technique involves determining the variability of the total solar flux based on measurements at several locations over the test region, while the temporal technique involves determining the variability of the total solar flux from a time series of measurements at a single location. The length of the time series is based on the wind speed at the cloud level. These statistics are being compared with similar statistics derived from the AIM predicted distribution of total solar flux over the test region but more tests are required to determine whether the resulting code is producing realistic results under most conditions. In particular, the code will be tested next under clear sky conditions and compared with measured Grayling I data. This should indicate whether the input illumination information is realistic. Following those trials we can compare the results with the overcast cases.

8. **SCHEDULE WITH MILESTONES:** Funding for this project was not received until second quarter FY98. Therefore the milestones presented in the table below have been advanced by one quarter relative to the original proposal.



FY98 AMIP PROJECT STATUS REPORT

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE:** Combat Service Support (CSS) Core Representation

2. **PROJECT ID:** AMIP-98-LOG-01

3. **SPONSORING AGENCY:** Directorate of Combat Developments for Quartermaster, USA Combined Arms Support Command (CASCOM)

4. **ACCOMPLISHMENTS:** The purpose of this project is to provide an automated program/data base that can rapidly identify and describe in detail what the essential CSS requirements are that should be portrayed in a model or simulation. This project uses the Subject Matter Analysis Retrieval Tool (SMART) from the Functional Description of the Battlespace (FDB) in order to give the CASCOM a unique environment, while maximizing code re-use on the development side. This program/data base is now known as the Logistics Description of the Battlespace (LDB). Currently residing in the LDB are the following: CSS Unit Model Diagrams (UMD) of a typical FSB; CSS Algorithms for stockage, medical evacuation and blood, and supply classes I, II III, and water; and a Task Model for the Supply Company of the FSB. Current support to CASCOM is provided through the Combat Service Support (CSS) index in the FDB document repository as well as through the FDB's CSS Special Interest Group (SIG) in the forum. This provides CASCOM (via the WARSIM 2000 FDB) the following capabilities:

   - Electronic Transmission of Data (via FTP)
   - Data Conversion
   - Data Storage
   - CSS Document Repository
   - Data Management
   - CSS Special Interest Group
   - Traceability of Transactions

5. **LESSONS LEARNED:** None.

6. **BENEFITS TO ARMY:** The LDB will provide all modelers (both Joint and Army) with an automated program/data base containing the minimum essential standard core CSS representation needed to simulate the CSS requirements of a United States Joint/Army force operating in a Major Theater of War (MTW) or any other contingency.

7. **WORK REMAINING TO BE COMPLETED:**

The LDB will provide CASCOM with a separate repository with the following characteristics:

   - Separate *URL* Used to Access CSS Core Representation
   - Pages Customized to CSS User Requirements
   - Provides All Functionality of Level 1 System
   - Administration Functions Transferred to Ft. Lee, VA

- Selected Maintenance Functions Transferred to Ft. Lee, VA
- Data & Software Reside on the FDB Server

Implementation of the LDB will be done in two phases. Phase 1 will realize the delivery of the following functionality:

- Customized Home Page
- Unique URL
- Assign/Add/Delete Password
- Separate Message Capability
- FORUM SIG Management
- Update Catalogue Entries

Phase 2 will include the additional functions:

- Remotely Import Data
- Add Catalogue Entries
- Update Validation/Schedule/POC Lists
- Automatic E-mail Notification
- "What's New" Mail Management

8. **SCHEDULE WITH MILESTONES:**

Monthly	Update on Status of Current Support
4 Aug 98	Coordination Meeting (Selection of Software Modules)
13 Nov 98	Phase 1 "On-Line"
25 Nov 98	Phase 2 "On-Line"
9 Dec 98	After Action Review

9. **POINT OF CONTACT:**

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE**: Single Army Battlefield Requirements Evaluator

2. **PROJECT ID**: AMIP-98-MOB-02

3. **SPONSORING AGENCY**: Strategic and Advanced Computing Center, DISC4

4. **ACCOMPLISHMENTS:** Significant progress was made in developing a standard sourcing tool for generation of forces. For FY98, the SABRE project went from the requirements solicitation and analysis phase to development of the first prototype. This involved on-site visits at FORSCOM and CAA, as well as electronic messaging with USAREUR for refinement of project requirements. It also encompassed developing and testing the software and hardware architecture and establishing database interfacing agreements. The primary software development focus thus far is giving non-technical users the ability to construct and submit complex, ad-hoc queries pertaining to the structure and content of Operations Plans. Our approach is to present terms and phrases that the end-user understands, and then dynamically build SQL statements on the fly based on combinations of terms and phrases that the user selects. This module is termed the 'sourcing manager'. The SACC has established a web site for the SABRE project over the SIPRNET for testing of demos as they are developed. This site has been operational since June 1998. This provides validation of the network on which the program will reside upon completion. This also provides the users not only the ability to work with the model, but actively participate in its development. The new SABRE model has thus far shown great promise. It was featured during the Intelligent and Emerging Technology conference (IET21) in July 1998. The SACC is scheduled to demonstrate the model to the Center for Army Land Warfare and DCSOPS in September 1998. In October 1998, SABRE will be part of a larger demonstration at FORSCOM to validate the feasibility of the Mobilization and Deployment Capability Assurance Project (MADCAP) model.

5. **LESSONS LEARNED:** The spiral development process has been extremely helpful in refining requirements, ensuring utilization, and speeding up fielding of the project. Spiral development is fielding iterative prototypes at the earliest stages and getting feedback from actual customers of the model as opposed to waiting until it is complete to unveil it to intended users. SABRE development is conducted on SACC servers in the Pentagon. SABRE users are all MACOM analysts in the field. A classified web-site on the SIPRNET was used to ensure that system development remained synchronized with user requirements. By providing a development web-site and placing the iterative demos on SIPRNET for testing, users have a means of ensuring the model is built to evolving specifications.

6. **BENEFITS TO THE ARMY:** The benefits to the Army are not measured solely by SABRE's ability to source a force. The old version of SABRE can still accomplish this task. The major benefit to the Army that the new SABRE model provides is a standard sourcing tool for force generation accessible from any desktop computer connected to the SIPRNET. There are no additional hardware requirements. There are no software requirements other than having a current browser (Internet Explorer or Netscape). No software must be installed onto a user machine. All data resides on a centralized server. The model is much more user

friendly. And it provides an increased force analysis capability. This is a huge improvement over the previous versions of SABRE.

7. **WORK REMAINING TO BE COMPLETED:** The primary portion of the work to be completed is to develop the SABRE sourcing engine and link it to the sourcing manager. The sourcing engine contains the algorithms that implement the filters, rules, and weighting scheme provided by the user through the sourcing manager. It interfaces with the various databases (SORTS, SAMAS, and TUCHA) and selects the best matching unit for a specified requirement according to the given input. Work is already well underway on this module and should be complete as scheduled. Other work to be completed includes developing a persistent user profile, creating technical and user documentation, ensuring high level architecture compliance, system validation, and migrating the model to the end-state server.

8. **SCHEDULE WITH MILESTONES:**

Nov 97 – Feb 98	Requirement Analysis	Complete
Apr 98	Architecture design	Complete
May 98	Software Selection	Complete
May 98	Establish Database Structure.	Complete
May 98	Create Web-page access to prototypes	Complete
Jun - Oct 98	Sourcing Manager Prototype dev/test	Complete
Sep - Nov 98	Sourcing Engine Prototype dev/test	Working
Nov - Dec 98	User profile database development	Incomplete
Jan – Mar 98	System Prototype Testing	Incomplete
Jan – Feb 98	System Validation	Incomplete
Apr 98	Migration to host server	Incomplete
TBD	Integration to GCCS-A	Incomplete

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE**: Standards for Engineer Mobility and Countermobility Operations in Modeling and Simulation

2. **PROJECT ID**: AMIP-98-MOVE-01

3. **SPONSORING AGENCY**: Waterways Experiment Station, USACE

4. **ACCOMPLISHMENTS**: The first three activities defined by the milestones, review doctrine, determine representation in E-OPS, and VIC-EFAM are well underway and near completion although funding (and reduced by 20%) was not received until near the close of the 2nd Quarter of 1998. Legacy M&S representatives at the Engineer School and TRAC have been contacted to coordinate review of other Army models. Additionally, this project has teamed with a Defense Modeling and Simulation Office (DMSO) project, Representational Resources Integration Experiment, to demonstrate a prototype standard for mobility and countermobility operations in JointSAF. This prototype will be transferable to OneSAF and lower resolution M&S.

5. **LESSONS LEARNED:** Not applicable at this time.

6. **BENEFITS TO ARMY**: Standards tend to produce improvements in consistency between M&S and also with C4I systems. The project will document recommendations for standards in mobility and countermobility operations in M&S in order to minimize such inconsistencies.

7. **WORK REMAINING TO BE COMPLETED**: A great deal of documentation is still in need of review to understand the various implementations of mobility and countermobility operations in M&S. This is especially true for the Legacy M&S. This work was originally scheduled to be completed by end of 3rd Quarter 1998, but will not be finished until late 4th Quarter 1998. Final documentation will not be completed until 1st Quarter 1999. The DMSO project will not be completed until 1st Quarter 1999 as well.

8. **SCHEDULES WITH MILESTONES**:

Events	Period of Execution				
	1Q98	2Q98	3Q98	4Q98	1Q99
Identify doctrinal responsibilities for M/CM		P	A		
Determine representation in E-OPS			A		
Determine representation in EFAM			A		
Determine representation in legacy M&S systems			P	A	
Final editing and publication of Mobility/ Countermobility standards				P	A
Note: P – Planned, A- Actual					

FY98 AMIP PROJECT STATUS REPORT

9. **POINT OF CONTACT:**

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE**: Air Battle Algorithms - Air Platform Movement

2. **PROJECT ID**: AMIP-98-MOVE-02

3. **SPONSORING AGENCY**: Army Model and Simulation Office (AMSO)

4. **ACCOMPLISHMENTS**: Research has been conducted to date on several simulations to include WARSIM 2000, ATCOM, and ModSAF. These represent high order combat models and low resolution with respect to aircraft flight performance duplication. In addition, other simulations/models, including ATTC's Flight Test Simulation Station (FTSS) and AMSAA's Helicopter Performance Model, have been included to represent high resolution aircraft performance algorithms. Expertise is being developed on the types of aircraft movement algorithms available both internal to the Army and DoD, and commercially. In addition to this, research into the types of aircraft performance MOPs/MOEs required has begun.

5. **LESSONS LEARNED**: Many of the upper-level combat models in use today do not replicate rotary-wing aircraft in much detail.

6. **BENEFITS TO ARMY**: A better set of aircraft movement algorithms would improve the overall capability of Army simulations and lead to potential standardization for all Army simulations. Standardization would improve agreement between existing models and simulations and ease comparison of results.

7. **WORK REMAINING TO BE COMPLETED**: Need to complete research on existing models to include Army, Air Force (fixed wing), and commercial products. Need to complete development of MOPs/MOEs. Need to determine best set of algorithms for possible standardization.

8. **SCHEDULE WITH MILESTONES**:

Events	Period of Execution				
	1Q98	2Q98	3Q98	4Q98	1Q99
Complete development of expertise pertaining to simulations		P		A	
Define MOPs/MOEs and requirements		P		A	
Complete research of existing algorithms and determine deficiencies		P		A	
Develop set of optimal algorithms			P		A
Document results & enter into SNAP			P		A
Note: P – Planned, A- Actual					

FY98 AMIP PROJECT STATUS REPORT

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE:** Standard Object Development

2. **PROJECT ID:** AMIP-98-OBJ-01

3. **SPONSORING AGENCY:** US Army Materiel Systems Analysis Activity (AMSAA)

4. **ACCOMPLISHMENTS:** The OMSC conducted a review, testing, and revision of the Platform Object and Unit Object for nomination as an Army object standard. Additionally, the OMSC developed the Location Object and the Data Object. The Environment Object template development, comprised of a Terrain Object, Atmosphere Object, Space Object, and Ocean Object, was initiated. Also initiated was a framework that defines the behaviors required in M&S and the development of an approach to integrate the behaviors into objects.

   - The following is a synopsis of the OMSC's FY98 accomplishments:

   - Platform Object. Using the component-based approach developed by the Standard Army Model and Simulation Objects (SAMSO) Study, the OMSC reviewed the SAMSO study approach and output related to the draft Platform Object. To explore the capability of the Platform Object to address expected M&S platform implementation; the OMSC conducted a number of M&S test applications. The simulations chosen for the test applications were the AMSAA Groundwars simulation and the TRAC-WSMR CASTFOREM/COMBAT XXI simulation. Additionally, to gain a broader perspective on the application of the draft Platform Object to other M&S domains, an overview of the draft Platform Object was provided to the Army M&S Management Program Working Group (AMSMP WG) and the Army M&S Standard Categories for review. Comments were collected to determine changes necessary to the Platform Object needed to address differing M&S requirements. Based on the review and application to a set of M&S, an updated version of the draft SAMSO Platform Object was developed and submitted to the Standards Nomination and Approval Process (SNAP) and the Army Standards Repository System (ASTARS). A report was written that documented the SAMSO study results; the test applications using Groundwars and CASTFOREM/COMBAT XXI; crosswalk with WARSIM 2000 and the Logistics SC set of combat simulation requirements; and the final set of Platform Object components, methods, and definitions.

   - Unit Object. As performed for the Platform Object, the OMSC reviewed the SAMSO study approach and output related to the draft Unit Object. To explore the capability of the Unit Object to address expected M&S implementation; the OMSC conducted an M&S test application. The simulation chosen for the test application was the TRAC-FLVN AWARS simulation. Additionally, to gain a broader perspective on the application of the draft Unit Object to other M&S domains, an overview of the draft Unit Object was provided to the Army M&S Management Program Working Group (AMSMP WG) and the Army M&S Standard Categories for review. Comments were collected to determine changes necessary to the Unit Object needed to address differing M&S requirements. Based on the review and M&S application, an updated version of the draft

SAMSO Unit Object was developed and submitted to the Standards Nomination and Approval Process (SNAP) and the Army Standards Repository System (ASTARS). A report was written that documented the SAMSO study results; the test applications AWARS; crosswalk with WARSIM 2000, ARES, and the Logistics SC set of combat simulation requirements; and the final set of Unit Object components, methods, and definitions.

- Location Object. This object consists of the Local Object and the LatLon Object. The notion of location is fundamental to most military simulations. There are numerous coordinate systems used in simulation, each appropriate for some simulations and not suitable for others. A common, abstract location object can foster interoperability among simulations that use different coordinate schemes. An initial report was drafted to define the objects, object methods, and object definitions.

- Data Object: This object consists of the Data Requestor, Data Collector, and Data Event Listener. This object allows the M&S user to use a general data services that can be tailored to address unique study analysis data requirements. A report is being drafted to define the objects, object methods, and object definitions.

- Environment Object. An Environment Object template was defined to represent the overall environment in which the simulation would transpire. The Environment Object is comprised of a Terrain Object, Atmosphere Object, Space Object, and Ocean Object. The OMSC initiated development of the Terrain Object and the object methods that are considered the minimum essential to represent terrain.

- Website Development. The OMSC created a website that lists the relevant documentation and briefings associated with FY97/98 object development.

5. **LESSONS LEARNED:** A significant lesson learned obtained from this project is the importance of conducting a "dry-run" application of proposed objects with existing or developmental M&S (e.g, CASTFOREM, AWARS, WARSIM). This allows one to gain confidence in the ability of the draft object to address the issue at hand as well as identify any areas that were not covered during the design phase. The project also provided strong validation of the applicability and flexibility of the component approach to object development. A second lesson learned deals with the importance of coordination of the proposed drafts with the M&S community. The OMSC coordinated with the P&T WG through AMSO and the SCs through the reflectors. Although comments received from the coordination were limited, those comments received did have important information that was used in the object refinement. Additionally, the coordination provided an educational aspect of the object development and, while only a limited number of comments were generated, the coordination messages were forwarded to other M&S development addresses that increased object development awareness.

FY98 AMIP PROJECT STATUS REPORT

6. **BENEFITS TO THE ARMY:** This project supports Army efforts to pursue model and simulation interoperability and reuse. The ultimate benefits to be derived from the availability of standard Army objects include:

   - reduced knowledge engineering development efforts for new models
   - enhanced interoperability/interactivity
   - reduction in duplication of effort, and
   - identification of investment opportunities to address modeling and simulation voids.

7. **WORK REMAINING TO BE COMPLETED:**

   - Publication of Platform Object Report
   - Publication of Unit Object Report
   - Coordination, and publication of the Location Object
   - Review, coordination, and publication of the Data Object

8. **SCHEDULE WITH MILESTONES:**

• Dry-run of Platform Object via Groundwars	Sep 97
• Dry-run of Platform Object via CASTFOREM/COMBAT XXI	Oct 97
• OMSC Website developed	Oct 97
• Dry-run of Unit Object via AWARS	Nov 97
• Dry-run of Unit Object via ARES	Dec 97
• Dry-run of Unit Object via WARSIM	Jan 98
• Refinement of Platform Object	Feb 98
• Refinement of Unit Object	Mar 98
• OMSC coordination of Platform/Unit Object	Apr 98
• Development of Data Object	Apr 98
• Development of Environment Object Template	May 98
• Coordination of Platform/Unit Object w/AMSMP WG & SCs	Jun 98
• Drafting/review of Platform Object Report	Jul 98
• Drafting/review of Unit Object Report	Jul 98
• Drafting/review of Location Object Report	Aug 98
• Drafting/review of Data Object Report	Aug 98
• Publication of Platform Object Report	Aug 98
• Publication of Unit Object Report	Aug 98
• Coordination/Publication of Location Object Report	Sep 98
• Coordination/Publication of Data Object Report	Sep 98

FY98 AMIP PROJECT STATUS REPORT

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE**: Implementation of a Common Behavioral Standard for ModSAF, CCTT SAF, and OneSAF

2. **PROJECT ID**: AMIP-98-SAF-01

3. **SPONSORING AGENCY**: TRADOC Analysis Center, TRADOC

4. **ACCOMPLISHMENTS**: The following Combat Instruction Sets have been selected for implementation in ModSAF: Occupy an Assembly Area, Execute Column Formation, Take Evasive Action, and Conduct Tactical Road March. A Subject Matter Expert has reviewed the programmer's conceptual diagrams and approved them. Some coding has begun on this project, and a prototype was shown at the June project review. The project will be completed on time for inclusion into the OneSAF Operational Testbed.

5. **LESSONS LEARNED:** The primary lesson learned is the need for up-front validation of conceptual diagrams in order to prevent any coding errors caused by incorrect software specifications. Such errors would not typically be caught until final testing, when it would be much more costly to fix.

6. **BENEFITS TO ARMY**: The entire Army will benefit in terms of entity level model interoperability because of the use of a common behavioral standard for model development.

7. **WORK REMAINING TO BE COMPLETED**: Remaining work to be completed includes additional coding and the final product demonstration. All work will be provided to the ModSAF and OneSAF configuration managers for inclusion in those baselines, as well as entered into SNAP.

8. **SCHEDULES WITH MILESTONES**: Documentation and coding complete by 1 November 1998 and sbmittal package prepared and presented to the ModSAF and OneSAF materiel developer by 31 December 1998.

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE**: Development of a Preprocessing Tool for Modular Semi-Automated Forces (ModSAF)

2. **PROJECT ID**: AMIP-98-SAF-02

3. **SPONSORING AGENCY**: TRADOC Analysis Center, TRADOC

4. **ACCOMPLISHMENTS**: A survey has been completed of requirements for a SAF preprocessing tool. Also, graphical user interfaces, and the editors used on them, have been reviewed and elements from the most successful identified for reuse. An initial design has been completed.

5. **LESSONS LEARNED:** Many editors are already in use throughout the SAF community, but no standard exists regarding file access or in the visual display of the editors. The human in the loop expects to see something similar each time he or she must edit a unit or entity for use in a scenario.

6. **BENEFITS TO ARMY**: The entire Army will benefit in terms of entity level model interoperability because of the use of a common editor standard for model development.

7. **WORK REMAINING TO BE COMPLETED**: Remaining work to be completed includes additional coding and the final product demonstration. All work will be provided to the ModSAF and OneSAF configuration managers for inclusion in those baselines, as well as entered into SNAP.

8. **SCHEDULE WITH MILESTONES**: Documentation and coding complete by 1 November 1998 and submittal package prepared and presented to the ModSAF and OneSAF materiel developer by 31 December 1998.

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE** The Effects of Vegetation on Line-of-sight for Dismounted Infantry (LOS in Veg)

1. **PROJECT ID**: AMIP-98-TERR-01

2. **SPONSORING AGENCY**: Topographic Engineering Center and TRAC-WSMR

3. **ACCOMPLISHMENTS**: Additional funds were obtained from: Rapid Force Projection Initiative (RFPI), the Tropic Test Center (TTC), the Cold Regions Test Center (CRTC), and the Canadian government to enable the data collection effort to be extended from eight weeks (eight sites) to 15 weeks (13 sites). On 22 August 1998, 13 of the 15 weeks of the ground truth data collection will be complete. Moreover, statistical analyses were conducted to compare climate and vegetation data for critical OCONUS tactical areas (such as Bosnia and Korea) to CONUS sites. These CONUS sites were visited (field data collection) and evaluated with the results to be included in the final report.

4. **LESSONS LEARNED**: A deeper appreciation of infantry requirements was developed and will be elaborated on in the final report.

5. **BENEFITS TO ARMY**: This program will provide curves and their equations for both probability of LOS as a function of range and probability of detection as a function of range. This information will be made available to both current Army models (SIMNET, Janus, and CASTFOREM) and to project leaders for future Army models (OneSAF).

6. **WORK REMAINING TO BE COMPLETED**: Two more sites will be visited to provide empirical data for this project. Analysis of field data and the development of P(LOS) and P(DET) equations still remain. Also, the final report has to be completed.

7. **SCHEDULE WITH MILESTONES**:

8. Sep 97 – Sep 98: Data Collection.
9. Sept 97– Dec 97: TEC and TRAC-WSMR provided emergency funding to get project started during the 1997 vegetative growing season (no AMIP funds available).
10. Jan 98 to present: AMIP funded.
11. Apr 98 – Dec 98: Analysis.
12. Jan 99 – Mar 99: Final Report and entered into SNAP

13. **POINT OF CONTACT**:

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE**: Architecture Alignment

2. **PROJECT ID**: AMIP-98-VIS-01

3. **SPONSORING AGENCY**: National Simulation Center, TRADOC

4. **ACCOMPLISHMENTS**: This project has further defined the team work required to integrate modeling and simulation (M&S) with digital command and control (C4I). To date, a survey of M&S, C4ISR, industry, academia, and research communities was done to define areas of focus and build a robust team. During the Standards Workshop, the Visualization Team developed a C4I Interface Model to categorize types of information shared between M&S and C4I. The C4I Interface Model will be briefed at the Fall 98 Software Interoperability Workshop. The C4I Interface Model was an azimuth change from the original plan to build a Visualization Standards Matrix and Templates. The model better serves the category in establishing standards with Data Interchange Formats (DIFs) than a matrix and templates. Standards developed from the model will impact HLA and DIICOE. The model also serves as the basis for developing a C4I Interface Reference Federation Object Model (FOM).

5. **LESSONS LEARNED:** The Visualization Standards Category needs to be renamed Visualization and C4I Integration. Visualization as it relates to sensory stimulation, battlefield visualization, and human interfaces occur primarily on C4I. The analyst, developer, and trainer all engineer GUIs to meet warfighter requirements and achieve information dominance. Standards development in this area must be in partnership with the C4I community. My team includes key personnel from not only the M&S community, but also the C4I community. Visualization and C4I Integration serves as the bridge between M&S and C4I.

6. **BENEFITS TO ARMY**: Integrating M&S and C4I efforts from concept, development, acquisition, testing, and training of C4I attains information dominance, reduces costs, and accelerate fielding as defined by Simulation Based Acquisition (SBA).

7. **WORK REMAINING TO BE COMPLETED**: Gain consensus on the C4I Interface Model from the Army and Joint M&S/C4I Communities. Draft and gain consensus on DIFs from M&S and C4I Communities.

8. **SCHEDULE WITH MILESTONES**:
   28 – 29 July 1998: FY98 4th Synthetic Environment Quarterly Review (STEQR) Team Workshop: C4I Interface Model, AMIP/SIMTECH 99.

   14 – 17 September 1998: Fall 98 SIW: Present C4I Interface Standards paper, Conduct Team Workshop on AMIP/SIMTECH 99 Projects.

   October 1998: MORS C4I Conference: Present C4I Interface Standards paper, and enter paper into ASTARS.

FY98 AMIP PROJECT STATUS REPORT

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FY98 AMIP PROJECT STATUS REPORT

1. **PROJECT TITLE**: Standards Nomination and Approval Process (SNAP) and Army Standards Repository System (ASTARS)

2. **PROJECT ID**: AMIP-98-AMSO-01

3. **SPONSORING AGENCY**: AMSO, HQDA

4. **ACCOMPLISHMENTS**: On 18 June the Army Model and Simulation Office (AMSO) reached full operation capacity (FOC) for the Standards Nomination and Approval Process (SNAP) (www.msrr.army.mil/snap) and the army Standards Repository System (ASTARS) (www.msrr.army.mil/astars).

   The Standards Nomination and Approval Process (SNAP) is the web-based tool that facilitates executing four steps of the Army M&S Standards Development Process: 1) define requirements, 2) develop standards, 3) achieve consensus, and 4) obtain approval. SNAP is fully integrated into the Army's seven step M&S Standards Development Process and is assessable via the Internet.

   At the heart of SNAP is the Standards Requirement Document (SRD). The SRD, an on-line form, is the first step in developing a new Army M&S standard; refining an existing standard; or nominating an accepted M&S practice, procedure, or technique to become a standard.

   To assist AMSO, Standards Category Coordinators (SCCs), and interested parties in the tracking of a draft - or in process - standard, SNAP has both a browse and a search capability. These allow a user to see a list of all in process and approved standards sorted in ascending SRD number, current status (All, In Process, or Approved), or Standards Category.

   Each Standards Category has a reflector and they are used extensively in the Army M&S Standards Approval Process as a forum to develop and achieve consensus on draft standards. SNAP automatically monitors this traffic and - as part of its database - maintains a copy of every reflector message sent. For those who have just joined a Standards Category, or for old hands, this feature allows one to review the on going debate on one or more draft standards and eliminates the need for current subscribers to maintain a copy of every reflector message sent. This unique feature permits individuals to enter the debate at any time during the define requirements, develop standards, or achieve consensus steps. SNAP also uses its reflectors to notify current subscribers of a given standards category when a draft standard is being developed or is being voted upon. This feature permits team members worldwide to actively participate without incurring cost travel expenses.

   When it has been determined that consensus has been achieved on a draft standard, SNAP will automatically send an electronic mail message to each appropriate Senior Reviewer. This message will contain a "hot-link" to that Senior Reviewer's voting page along with information on the draft standard. Provided they have Internet access, the Senior Reviewer can select the "hot link" and be taken directly to their voting page.

FY98 AMIP PROJECT STATUS REPORT

The approving authority for all Army M&S Standards is the Deputy Under Secretary of the Army for Operations Research (DUSA(OR)). Once a standard has been approved, it is placed in ASTARS. For each standard in ASTARS, you will find at least information about the standard and a point-of-contact. To the maximum extent practical, all of the items described in ASTARS will be available to the public for download. However, classified standards will not be stored in ASTARS. Those standards not available for public release will follow the release procedures for M&S described in Army Regulation 5-11.

5. **LESSONS LEARNED:** The Beta Test was conducted 1 March through 15 April 1998. SCCs served as the beta tester. Their feedback and suggestions came from the perspective of how to they would implement the systems. Their comments were incorporated into the FOC version of the systems. During the Standards Review meeting September 9 concern was expressed about the utility of the search engines from an M&S developers perspective. A lesson learned was that wider user participation during the development phase – perhaps an Integrated Product Team (IPT) to help better define user interfaces – should have been sought.

6. **BENEFITS TO ARMY**: SNAP and ASTARS provide the M&S community with a single place to locate existing standards and to initiate development actions when their requirements fail to be met. The introduction of these web-based forums permits a wider community to participate in the development of future standards while avoiding costly travel expenses. This provides immediate access to anyone with Internet capability and proper permission.

7. **WORK REMAINING TO BE COMPLETED**: N/A

8. **SCHEDULES WITH MILESTONES**: Original delivery date was 30 September 1998. ASTARS was delivered on 18 June 1998; over 90 days early.

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FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

1. **PROJECT TITLE:** Development of a Data Collection and Analysis Tool under the High Level Architecture using Autonomous Agents (DCAT-AA)

2. **PROJECT ID:** SIM-98-AMC-01

3. **SPONSORING AGENCY:** US Army Aviation and Missile Command (AMCOM), Missile Research, Development, and Engineering Center (MRDEC)

4. **ACCOMPLISHMENTS:** The Data Repository and Analysis Tool portion of the project is complete. The database schema for storing experiment data, the mining techniques, and the display of pertinent data have been developed and tested. The Autonomous Agents Control Station has been prototyped and is nearing completion. The Autonomous Agents are under development but have fallen behind schedule.

5. **LESSONS LEARNED:** Development of HLA compliant tools during the HLA standards development process provides unique challenges. Autonomous Agent technology has a number of inherent limitations due to Department of Defense imposed network security measures. Autonomous Agent development tools are not being developed as rapidly as expected. Autonomous Agents injection into remote networks requires installation of additional server software in the remote network.

6. **BENEFITS TO ARMY:** Work completed to date has aided in the understanding of useful implementations and the limitations of Autonomous Agent technology as applied to Army problems. In addition, the data collection and analysis tool component has demonstrated an easy to use yet powerful data mining capability for decision-makers during run execution.

7. **WORK REMAINING TO BE COMPLETED:** Completion of the Control Station and Autonomous Agents portion of the project. Specifically, interfacing the Autonomous Agents with the RTI and enabling proper data subscription routines within the agents themselves. Finally, integration and testing of the entire infrastructure is not complete.

8. **SCHEDULE WITH MILESTONES:**
   - Completion of the Autonomous Agent Control Station - 31 October 1998
   - Completion of the Autonomous Agents - 15 December 1998
   - Integration and Testing of all Components - 31 December 1998

9. **POINT OF CONTACT:**

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FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

1. **PROJECT TITLE:** Simulation Support Environments (SSE) for Army Modeling and Simulation (M&S)(SSEAMS)

2. **PROJECT ID:** SIM-98-AMC-02

3. **SPONSORING AGENCY:** Army Materiel Systems Analysis Activity, Army Materiel Command

4. **ACCOMPLISHMENTS:** This is the second year of a two year project in which we are evaluating JMASS as a simulation support environment for Army M&S activity. To support this evaluation, we are using JMASS to build and exercise a JMASS compliant version of Incursion, a one-on-one Air Defense engagement simulation. Incursion is an Army standard simulation that is used to generate Air Defense Effectiveness estimates for force level simulations such as VIC and Eagle. The JMASS version of the Incursion simulation is a side benefit of this project. The objective of the project is to gain a better understanding of SSE's and their ability to support Army needs and to apply this understanding in support of the ongoing OSD JMASS initiative. This section describes what we have done to carry out the evaluation of JMASS, namely the model development effort and testing of other JMASS functions. The more significant accomplishments, applying what we have learned to support the OSD JMASS initiative and other M&S activities are discussed in paragraph 6.

   In the first year of the project, we developed a C++ version of the Incursion model in a Unix environment, and initiated development of a JMASS version. The C++ /Unix version served two purposes. It allowed us to get an early start on the project, including learning the C++ language, and it provided a baseline to which the JMASS development could be compared. In the second year, we have continued development of the JMASS version. A number of problems with JMASS have been found through this development and we have identified these to the JMASS support office and have worked with that office to resolve many of them. This process is continuing. One problem that is still being worked has held up model development for some time. This problem first surfaced while we were using JMASS 3.1. Since that time, we have received and installed JMASS 3.2. We used the JMASS backup and restore capabilities to move the Incursion models from 3.1to 3.2. We found that this process worked very well. We also found that a number of the problems we had encountered in JMASS 3.1 had been corrected. Unfortunately, this did not include the problem that was causing the development delay.

   More recently we have received the JMASS PC Prototype. This version does not include all the tools that come with versions 3.1 and 3.2 (no back up and restore for example), but it does have a number of significant improvements that will be included in future versions. We have now ported the Incursion models to the PC Prototype. In addition to the more visible improvements, the difficulty we were having in JMASS 3.1 and 3.2 appears to be resolved. Using the PC Prototype, we can now run the models that would not run under 3.1 or 3.2. As a result, model development is now continuing and will be completed in August.

In the meantime, we have used completed parts of the JMASS Incursion model and players provided for the JMASS tutorials to exercise and test other aspects of JMASS, including scenario development, simulation configuration, simulation execution, and analysis modes.

5. **LESSONS LEARNED:** There are many aspects and ideas involved in an SSE such as JMASS. At the core is the recognition that there are certain principles of software design that simplify development, maintenance and reuse of M&S. The SSE provides standards and tools that make it easy for M&S developers to follow those principles. One thing we have learned through this project is that these software design principles apply to software other than M&S. In particular, developers of the software that implements an SSE can and should employ the same principles of software design that their system will enforce on its users.

6. **BENEFITS TO ARMY:** The OSD JMASS initiative seeks to establish a tri-service standard simulation support environment. Through this project, we are supporting DA participants in this initiative to ensure that this standard will meet Army M&S needs. In addition, we are producing an updated version of Incursion which is more flexible to use, easier to modify and maintain, and has, through JMASS, the potential for further improvements, such as few-on-few capabilities and HLA compliance.

   The information we have acquired has already proven valuable in several areas. We participated in development of the Joint Operational Requirements Document for the OSD JMASS and have provided briefings to DA to support decisions regarding this program. The information gained is also proving valuable in supporting other Army M&S efforts. We are currently working with TRAC-WSMR to use the JMASS PC Prototype to develop and test objects for COMBAT XXI. We also have an ongoing exchange of information on SSE's with the French Center for Defense Analysis.

7. **WORK REMAINING TO BE COMPLETED**: The tasks remaining are to complete the JMASS compliant version of Incursion in the PC Prototype and write a report giving results and observations.

8. **SCHEDULES WITH MILESTONES**:

Mr. Hollis and Dr. Fallin briefed in preparation for 4 Mar SSG	Feb 98
JMASS 3.2 installed	Mar 98
Developmental Incursion ported to JMASS 3.2	Mar 98
JMASS PC Prototype installed	May 98
Dr. Fallin and Mr. Bettencourt briefed in preparation for 6 Jun SSG	Jun 98
Developmental Incursion ported to the PC Prototype	Jun 98
JMASS Incursion completed	Aug 98
Report written	Sep 98

FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

9. **POINT OF CONTACT:**

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FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

1. **PROJECT TITLE**: Mutual Enhancement of the Virtual Environment Database Server and the Soil Response Modeling Effort

2. **PROJECT ID**: SIM-98-AMC-03

3. **SPONSORING AGENCY**: US Army Aberdeen Test Center (ATC), Test and Evaluation Command (TECOM), Army Materiel Command (AMC)

4. **ACCOMPLISHMENTS**:

   a. Aberdeen Test Center partnered with the Army Corps of Engineers, Waterways Experiment Station (WES) and Cold Regions Research and Engineering Laboratory (CRREL) to begin the soil characterization and wheeled vehicle phase of the project.
   b. ATC recorded four soil samples at each of three test locations, soft soil, moderate soil and hard packed soil. CRREL provided a fully instrumented, wheeled vehicle, a 1977 Jeep Cherokee, with known dynamic characteristics and performance properties. Test trials were conducted over each of the soils at constant speeds of 5 and 10 miles per hour. ATC also conducted acceleration tests in each of the soils.
   c. Vehicle data measured included tractive force, rolling resistance, tire depth, vertical, longitudinal and side loading of the tires.

5. **LESSONS LEARNED:**

   a. After the first pass on the soft or loose soil, very little further compaction takes place. That is, the rut depth is not progressive.
   b. Surface preparation should be performed immediately prior to test. If too much time elapses between preparation and test, the surface must be re-prepared and soil samples retaken. Understanding the sensitivity of surface preparation to mobility results may change soft soil test procedures in the future.

6. **BENEFITS TO ARMY**:

   a. ATC, WES and CRREL have formalized a partnership to improve the Army's mobility and soil models. ATC will provide data collection techniques and expertise while WES and CRREL will use the data to enhance soil and snow mobility models.
   b. When completed, this project will result in a procedure for validating tire models and constructing a database of tire and soil performance data. Future instrumentation techniques will be refined to meet the needs of the soil, snow and tire mobility modelers.
   c. The soil and mobility data will be integrated into the Virtual Proving Ground (VPG) Virtual Environments Database Server (VEDS) for use by any DoD agency.

7. **WORK REMAINING TO BE COMPLETED**:

   a. ATC, WES and CRREL will reduce and analyze the wheeled vehicle test data.

b. ATC will repeat the mobility test with a tracked vehicle, an instrumented M113 Armored Personnel Carrier. In addition to the data collected for the wheeled vehicle, ATC will measure road arm displacements and accelerations for inclusion into an Army Research Laboratory (ARL) driver model. The development of the driver model is a deliverable under a Technology Program Annex (TPA) between ATC and ARL. By leveraging SIMTECH and TPA funds, ATC will complete both the wheeled and tracked vehicle portions of this project with reduced funding.

c. ATC will update the VEDS.

8. **SCHEDULES WITH MILESTONES**:

Event	Start Date	End Date
Wheeled Vehicle Test	3 Aug	7 Aug
Data Reduction and Analysis	17 Aug	21 Aug
Tracked Vehicle Test	24 Aug	4 Sep
Data Reduction and Analysis	8 Sep	18 Sep
Final Report		30 Sep
Update VEDS		30 Oct

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FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

1. **PROJECT TITLE** Comparative Simulation State and Path Research/Interpretation (SimPaths II)

2. **PROJECT ID**: SIM-98-CAA-01

3. **SPONSORING AGENCY**: U.S. Army Concepts Analysis Agency

4. **ACCOMPLISHMENTS**: This on-going research has addressed several long-standing but too frequently ignored issues relevant to hierarchical analytic modeling and simulation. A key premise of hierarchical modeling (e.g., CAA's COSAGE/ATCAL/CEM hierarchy for theater campaign analysis) is that a small amount of "high resolution" information about a small reference set of combat engagements is sufficient for estimating the results of an unlimited number of other engagements that differ from the reference set with respect to, for example, starting strengths and unit frontages. The work is heavily mathematical and is intended to develop principles, reduce them to practice, and provide sound underpinnings in several areas where there are few to none. Research to date is very promising. What may be unclear to the non-mathematician is that this research is primarily about refining rules for and generation of necessary and sufficient evidence in decision-making based, in part, on combat modeling and simulation. Within the context of battlefield engagements, it is about generating a spanning set of practical alternatives, dynamically creating the relative values of alternatives, and choosing the very good, if not the best option. First, imagine a scenario so strict that a simulation need do no more than follow a detailed script. Then, loosen up the script and let the simulation discover some alternatives and make choices. In this view, the project might be renamed "scenario relaxation research" and be seen to lie at the roots of command and control and other fundamental combat processes.

    a. Dr. Gilmer is trying to extract more information about reference sets of engagements by having simulations follow several of the possible paths within a "single simulation." Here, a "path" is much more than a succession of geographic positions; it is a succession of "locations" in a combat state space including the quantities of troops and materiel engaged. Clearly, not all possible, or even probable, paths may be followed for a simulation of acceptable scope and resolution. At most, only a subset may be followed explicitly. Gilmer's research is most easily understood in terms of an algebraic analogy. Any vector in an n-dimensional linear space may be represented in terms of n linearly independent vectors, a "basis." Gilmer is defining "path space." He is determining the "dimensionality" of path space. He is trying to manage "muli-path simulation" in a way that generates a "best basis" of paths. "Best" implies the existence of "metrics" for measuring the differences among paths. Definition of metrics is also part of the research. The research includes reducing the analogies to executable examples. Gilmer has done that for "toy" problems of limited scope and resolution. Scaling the simple examples upward to useful and practical levels is, not surprisingly, more difficult. To the extent that any one path may be considered a sample from path space, Gilmer's work may be viewed as determining how many and which samples are necessary and sufficient to span path space.

b. The allocation of targets among shooters may have significant effects on the path (in the above sense) that an engagement follows. Target allocation may be tightly prescribed in advance by the imposition of some given set of "target values." Or target allocation may be done more dynamically by, in effect, computing target values "on the fly." Here the notion is that many courses of action may be feasible but that some are better than others. Because "better" may not be fully determinable in advance, much must be determined on the fly. Allowing more dynamic determinations gives modeling much more of an analytic flavor with appeals to, among other things, control, game, and optimization theories. Target values and other value-like measures may then be viewed as "dual variables" or, at worst "pseudo-duals." This infusion of mathematics into ordinary simulation is a specialty of Dr. Robinson.

c. The utter frustration in trying to determine what any particular simulation does and does not do should make two things clear: (1) Not enough effort has been devoted to describing how simulations are alike and how they differ, and (2) The framework for expressing comparisons is at once incomplete and ambiguous. Model documentation is seldom what is should be or purports to be. Dr. Taylor, initially for the target allocation/attrition domain, is evolving a framework and applying it to several of the most used methods. He has summarized his early work in a scripted briefing, "Research on the Comparative Evaluation of Attrition-Modeling Methodologies." The briefing provides pair-wise comparisons among three methods.

1. **LESSONS LEARNED:** Like many analysts before us, we find that combat simulation remains an area subject mainly to very casual rules of evidence. Sharpening and applying the rules is a challenge welcomed by the researchers. a. Dr. Gilmer demonstrated proof of principle for multi-path methods with a small model, "eaglet." Scaling upward has introduced foreseen as well as unexpected problems. Developing and maintaining the corresponding software across platforms is improving robustness of algorithms but has taken longer than planned. b. Dr. Robinson has found that, although CAA's ATCAL uses target importances much as though they are dual variables, the importances do not satisfy the strict definition of duals (i.e., shadow prices). c. Dr. Taylor has discovered that the popular descriptions of several algorithms and models and Lanchester-like or Bonder-Farrell-like tend to be misleading, though not deliberately so.

2. **BENEFITS TO ARMY**: a. & b. In the longer run, the researches of Drs. Gilmer and Robinson should assist in providing more nearly necessary and sufficient modeling input and output, assuring that full sets of alternatives are addressed fairly, and that selection criteria are less ad hoc and are applied appropriately. c. In the short run, the similarities and differences among modeling methods (initially, for target allocation/attrition) will be clarified. A broader based, more nearly objective method will be provided to assist in the selection of combat models and submodels.

3. **WORK REMAINING TO BE COMPLETED**: Very broadly, all the researchers are striving to make incremental improvements in the ways in which modeling and simulation are used to generate evidence. a. Dr. Gilmer actually had two prototypes: "Gilmer's method"

and "Sullivan's method." Sullivan is a colleague of Gilmer. Each method has some unique desirable features. Gilmer is in the final stages of making Sullivan's method the official version. He is building and testing two scenario generators. These and a few other tasks are largely matters of "tidying up the software." If that goes well, this year's work will include tests of several strategies of trajectory management. If not, trajectory management may depend most heavily on a stochastic, brute force "breadth first" exploration of trajectories. Otherwise, a potentially more efficient "depth first" method may emerge. b. Dr. Robinson continues to develop technical software tools to deal with peculiarities and instabilities. With the tools, he will identify preferred shadow-pricing models for comparison with and perhaps replacement of ATCAL importance calculations. c. Dr. Taylor has the easiest task. He will add additional criteria to his comparative schema, generalize from pair-wise to n-way comparisons, and apply the method to two more target allocation/attrition methods (or variants). He expects to make recommendations for improving current methods. All researchers will document their work.

4. **SCHEDULE WITH MILESTONES**: Drs. Gilmer and Robinson are doing pioneering multi-year research. Their goals, noted above, are clear, but, as in most research, major victories must await overcoming many technical details. a. Dr. Gilmer devoted more time than expected to tidying up software problems left over from earlier prototyping. But, as a result, he overcame several machine dependency issues. By the end of FY98, he will test somewhat less than the originally planned range of possibilities conceived for managing multiple trajectories in the face of larger simulated engagements. On the other hand, he discovered some alternative techniques that may prove useful if not life-saving. A "leftist tree" mode appears to be a major discovery and a key to upward scalability. An IPR is planned for late August with an interim report in September. b. By the end of FY98, Dr. Robinson expects, with focus on ATCAL-like importance measures, significant progress in improvement in his MATLAB homotopy code to deal with peculiarities of Nash equilibrium structure, determination of a regularization scheme to remove objectionable instability, identification of a preferred class of shadow-pricing models, and extensive computational comparison among importance and shadow-pricing methods. Results will be presented in an FY98 interim report. c. Dr. Taylor, at the end of FY98, will document his expanded comparative framework with application to several current methods.

5. **POINT OF CONTACT**:

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FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

1. **PROJECT TITLE:** Port Simulation Model (PORTSIM) 3-Dimensional (3D) Visualization System

2. **PROJECT ID:** SIM-98-MTMC-01

3. **SPONSORING AGENCY:** Military Traffic Management Command Transportation Engineering Agency (MTMCTEA)

4. **ACCOMPLISHMENTS:** Partial funding ($60K) for this effort did not arrive at the contractor until after March 1998. To date, the 3D virtual environment (Garden City Terminal-Savanna, GA), the generic vehicle/MHE object libraries, and one textured ship object have been completed. Environment/Geographical Information Systems (GIS) data link has been established via the Route and Landmark Selection Tool (RULST). The preliminary completion of a graphical user interface (GUI) by Argonne National Lab is complete.

5. **LESSONS LEARNED:** The further refinement of the 3D environment and GUI has been hampered by the lack of support from future customers of this capability. While there has been great interest for 3D visualization from the upper echelons of the transportation community, at this time, other organizations need to define specific use cases or functional requirements that will help further develop this capability.

6. **BENEFITS TO THE ARMY:** This effort is a key component to the Virtual Sealift Emergency Deployment Readiness Exercise (SEDRE). With the reduction in the numbers of SEDREs performed in a year, the Army deployment community needs alternative methods to train and prepare units for actual deployments. The Virtual SEDRE will simulate and visualize the deployment activities that occur at specific installations and ports and supplement and complement live SEDREs and deployments. The Virtual SEDRE will allow deploying units, transportation movement officers, port commanders, and transporters, in general, to exercise deployment plans, rehearse missions, and visualize the defense transportation system in simulation, thus improving upon actual deployments and exercises.

7. **WORK REMAINING TO BE COMPLETED:** Verification of technical adequacy of all object structures. Completion of simulation routings and refinement of the visualization scenario. Addition of task specific enhancements to the GUI. Linking of PORTSIM simulation to the 3D viewer and virtual environment.

8. **SCHEDULE WITH MILESTONES:**

   - Develop 3D virtual environments for a specific seaport (Garden City Terminal-Savannah, GA) - complete
   - Build PORTSIM visualization graphical user interface (GUI)/viewer - complete
   - Design/build/test interface b/w GIS, 2D animation, and 3D visualization – Oct 98
   - PORTSIM results using 3D visualization system – Oct 98

FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

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FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

1. **PROJECT TITLE**: USAR Resources to Readiness (R2R)

2. **PROJECT ID**: SIM-98-OCAR-01

3. **SPONSORING AGENCY:** Program, Analysis and Evaluation Division, Office of the Chief, Army Reserve

4. **ACCOMPLISHMENTS**: Led an OCAR/contractor (CALIBRE Systems Incorporated) project team in developing the Resources to Readiness (R2R) simulation and conducted a verification, validation and accreditation in accordance with AR 5-11 within the resources provided to us by the DUSA (OR). This model is a PC-based simulation tool designed to enhance the POM design decision-making processes. Used to perform quick analysis of potential changes to resourcing positions and alternative funding strategies, this tool helps the OCAR staff to articulate credible, reliable and compelling analysis in support of rational resourcing positions. Development work to date has included working group sessions across the full spectrum of the OCAR staff. In addition to the model, a conceptual framework was developed, in graphical format, which is widely used across the staff. During the model development period, many cross-functional issues were surfaced and resolved before becoming POM issues. Examples of this behind-the-scenes work included identification of ambiguity in funding responsibilities for additional training assemblies between the Manning and Training PEGs and resourcing requirements for the equipping PEG. As directed by the DUSA (OR), the OCAR/contractor project team has accredited the model in accordance with Army Regulation 5-11, Chapter 5. In accordance with Army Regulation 5-11 the model has been accredited for the following applications:

   - The migration of OPTEMPO funds to
     - BASOPs
     - Information Management
     - MILTECH Salaries
     - Schools
     - RPM
   - A change in the number of (maintenance) MILTECHs
   - A change in recruiting funds
   - A change in the annual loss rate

   Finally, the model received an accreditation level of 2 from the members of the accreditation committee. The accreditation committee was comprised of:

   BG Helmly, Deputy Chief, Army Reserve
   Dr. Craig College, Deputy Director, Program Analysis and Evaluation
   Mr. John Riente, Scientific Advisor, Deputy Chief of Staff, Operations and Plans

FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

5. **LESSONS LEARNED**:

a. The single greatest lesson learned was the enormous difficulty in relating a quantifiable input (Resources) to outputs that in many respects cannot be quantified. In every case that we did not have a quantifiable output we DID NOT model that particular process. Specifically, and to our great disappointment, we were not able to link Active Guard/Reserve (AGR) soldiers to a quantifiable measure of readiness. This is not to say that we did not spend a great deal of "intellectual capital" trying to build that relationship. We believe that AGR soldiers play an invaluable role in the USAR providing trained and ready units to the Army. Furthermore, we believe that AGR soldiers are the standard bearers for the USAR. Unfortunately, we were just not able to find a quantifiable link between AGR soldiers and a quantifiable output measure contributing to readiness. We ran into the same challenge when we examined the Individual Mobilization Augmentee (IMA) soldiers and the Department of the Army Civilians (DAC).

b. The lesson of "not trying to make chicken salad without chicken" proved to be invaluable when we got to the Verification, Validation and Accreditation phase of the project. We fully understood the challenges our team would face in describing the linkages between processes. However, what we did not anticipate was the tremendous difficulty in gaining agreement from different subject matter experts. This difficulty was exacerbated during the VVA process. With that understood, there is no question that the VVA process is an integral piece of any model or simulation development project. The lessons we learned from exposing our simulation to highly respected leaders and analysts OUTSIDE of the USAR produced a viable and useful simulation.

6. **BENEFITS TO ARMY**: For the applications that have been accredited, the USAR has a simulation tool that can be used to perform quick analysis of potential changes to resourcing positions and alternative funding strategies. This tool helps the OCAR staff to articulate credible, reliable and compelling analysis in support of rational resourcing positions. In terms of benefit to the Army, the USAR has shown that the very complicated issue of relating different forms of resources to different outputs of readiness can be accomplished to a limited degree. If any agency chooses to embark on a project such as this we would strongly recommend that they leverage the lessons we learned and utilize a software tool such as ithinkTM. The ithinkTM software was an excellent choice for a type of project in which complicated interdependent relationships must be articulated.

7. **WORK REMAINING TO BE COMPLETED**: None

8. **SCHEDULE WITH MILESTONES**:

March 1998	Completed review of existing map and simulation model with PEG staffs.
May 1998	Completed review of algorithms with PEG staffs.
June-August 1998	Supported summer POM drills with simulation tool. Evaluated suitability of tool for use in planning and budgeting, as well as program development.

FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

9. **POINT OF CONTACT**:

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FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

1. **PROJECT TITLE**: Multi-Resolution Modeling (MRW)

2. **PROJECT ID**: SIM-98-ODCSINT-01

3. **SPONSORING AGENCY**: ODCSINT

4. **ACCOMPLISHMENTS**: Funds ($83,000) were received 23 July 1998. As of 7 August 1998, funds ($82,994) were obligated on an existing contract between National Ground Intelligence Center and the University of Virginia. UVA personnel to perform the tasks delineated in the Statement of Work have been identified and a work action plan has been developed. There is no progress on the research at this time since the funds were received only two weeks ago.

5. **LESSONS LEARNED:** Since funds were just received, there are no lessons learned that can be reported now. However, NGIC anticipates that, upon execution of this study, an approach to maintain consistency across multiple, concurrent representations of battlefield entities will be available.

6. **BENEFITS TO ARMY**: Multi-Resolution modeling (MRM) is concerned with resolving conceptual and representational differences that arise from multiple levels of resolution in simulations that are joined for a common objective. Even assuming valid simulation models, MRM is a challenging aspect of interoperability of simulations that were designed and implemented independently. Traditional MRM solutions employ aggregation and disaggregation. These techniques can cause temporal and mapping inconsistencies, chain disaggregation, network flooding and high transition latencies. Existing solutions meant to solve some or all of these problems leave the central consistency problem unresolved. UVA proposes to use Multiple Resolution Entities (MREs) to maintain internal consistency across multiple, concurrent levels of resolution. Each MRE maintains state information at all desired levels of resolution or furnishes information at a requested level in a timely manner. This proposed technique will be tested during this research effort and, if effective, may solve one of the most difficult remaining unsolved model interoperability issues.

7. **WORK REMAINING TO BE COMPLETED**: Relationships among attributes detailed in the NGIC object-oriented analysis of fire support will be captured using a directed, weighted graph wherein the nodes represent attributes and the edges between nodes represent relationships. From this, consistent models for fire support resolution will be built. Once the models have been established, consistency maintenance within multiple levels of resolution will be incorporated. The ability to maintain consistency between multiple levels of resolution for these entities, the quality of the consistency achieved, and the costs associated with maintaining the consistency will be evaluated. Results will be detailed in a technical report with appendices containing the constructed models.

FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

8. **SCHEDULES WITH MILESTONES**:

Contract award	7 August 1998
Obtain model FOMs, SOMs	1 September 1998
Develop fire support entities	1 November 1998
Construct attribute dependency graphs	1 January 1999
Incorporate consistency maintenance	1 March 1999
Measure quality of consistency maintenance	1 May 1999
Assess costs	1 June 1999
Write report	1 July 1999

9. **POINT OF CONTACT**:

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FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

1. **PROJECT TITLE:** Simulation Testing Operations Rehearsal Model – Visualization System (STORM-VS)

2. **PROJECT ID:** SIM-98-OPTEC-01

3. **SPONSORING AGENCY:** OPTEC

4. **ACCOMPLISHMENTS:** Software has been developed to capture and display test player movement and interaction (engagements) for both the live and virtual test environments in real-time and playback modes. The STORM-VS prototype uses a map image background and displays players as icons, player numbers, or player names. The player symbols move based on data packets received from the network. Players can be either live entities in the field or simulated entities from the associated JANUS constructive simulation. Live players from whom no data packets have been received in a user-selectable amount of time have their symbols change to a different color to show "staleness" of information.

5. **LESSONS LEARNED:** Coordination with the STORM development team was essential because it ensured success of the visualization effort. Coordination also helped to maintain low risk for the project and an on-time delivery schedule necessary to support the Force XXI Battle Command Brigade and Below (FBCB2) operational test.

6. **BENEFITS TO THE ARMY:** The STORM-VS system provides visibility and insight into the conduct, outcome, and meaning of operational test data involving live and virtual players. The system allows the user to see what is happening or what has happened. It shows the spacial and temporal relationships among the players and their interactions. It facilitates analysis and after action reviews by enabling flexible creation of after action review products to enhance post-trial briefings for both players and the analytical community.

7. **WORK REMAINING TO BE COMPLETED:** STORM-VS will accept and process all data packet types available from the live instrumentation and the Janus combat simulation. This requirement is about 75% completed; the remaining 25% will be completed in FY99.

8. **SCHEDULES WITH MILESTONES.**

Interim testing of STORM-VS in the overall STORM system	Aug 98
Incorporation of all data packet types	Apr 99
Final testing of STORM-VS	Aug 99
Application of STORM-VS in FBCB2 Operational Test	Sep 99

FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

9. POINTS OF CONTACT:

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FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

1. **PROJECT TITLE**: Tactical Simulation Interface Unit (TSIU) Army Battle Command System (ABCS) Compatibility

2. **PROJECT ID**: SIM-98-SMDC-01

3. **SPONSORING AGENCY**: Space and Missile Defense Battle Lab (SMDBL), U.S. Army Space and Missile Defense Command (USA SMDC)

4. **ACCOMPLISHMENTS**: A TSIU requirements matrix was developed, identifying those requirements that already meet the COE, those requirements that need modifications to meet the COE, and those requirements unique to the TSIU. The Maneuver Control System (MCS) was chosen as the target system for ABCS testing. The TSIU has been internally evaluated, as compared to the evaluation criteria established for Runtime Environment Compliance levels, to be Level 4, Bootstrap Compliance Level. A schedule is currently being developed that parallels the COE development path for MCS and full COE compliance, Level 8. COE segments have been identified.

5. **LESSONS LEARNED:** None

6. **BENEFITS TO ARMY**: The U.S. Army is rapidly fielding digitized Command, Control, Communications, Computers, and Intelligence (C4I) systems to the warfighter for use in Tactical Operations Centers (TOCs). The current fielding schedule will provide a digitized division in FY00 and a digitized corps in FY04 as part of Force XXI, with other divisions and corps to follow. In order to maximize the return on C4I investment, an inexpensive collective training capability is required.

   The simulation interface capability to allow effective collective training between TOCs and individual workstations within a given TOC has not kept pace with the digitization efforts. A major deficiency is an interactive interface between simulations and command and control entities. In the current context of providing a collective training capability, the interfaces currently being supported suffer from a variety of deficiencies. These deficiencies include but are not limited to: lack of user friendliness, large resource overhead to operate, development does not parallel the development path of the ABCS, and an inability to address only a minimal number of ABCS. This project will help correct these deficiencies.

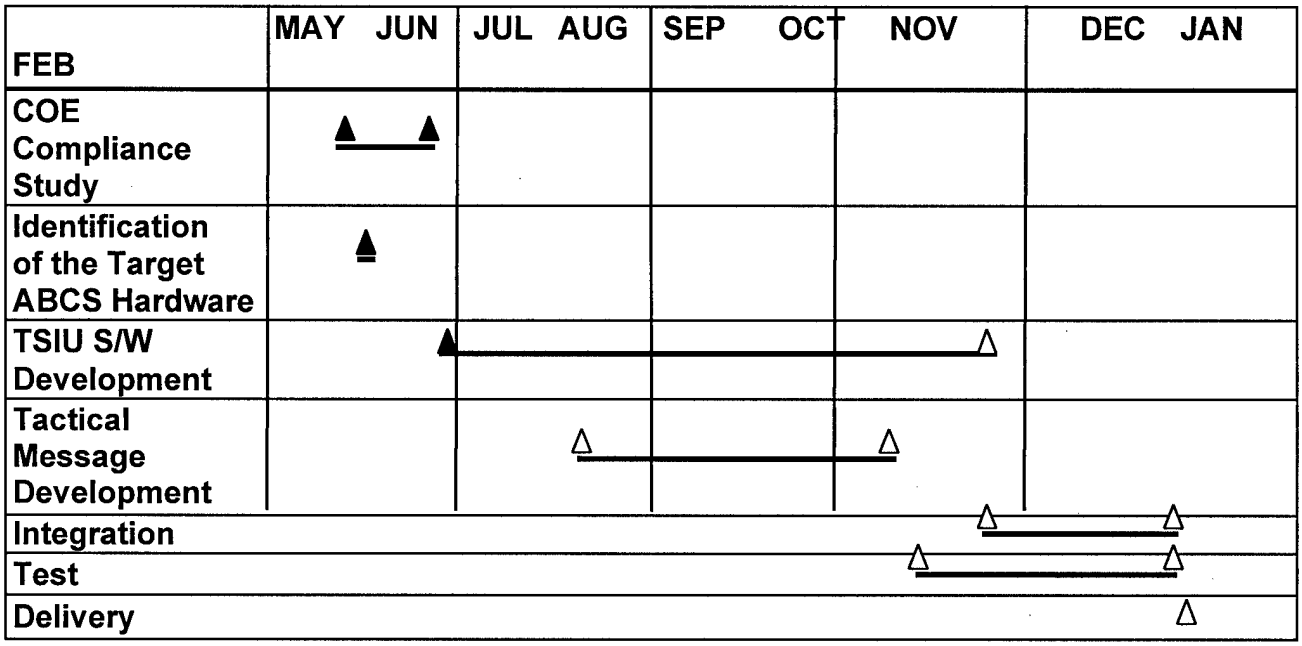
   This project is evaluating, testing, and implementing within the TSIU, a Defense Interface Infrastructure Common Operating Environment (DII COE) compliant system. As future ABCS and other hardware/software systems migrate to DII COE compliance, this project will allow the TSIU to maintain a parallel software development path. This project also addresses other deficiencies by providing a leave behind, user friendly, government owned system, capable of testing Army Battle Command System (ABCS) hardware/software and training users on their "go to war" ABCS workstations.

FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

7. **WORK REMAINING TO BE COMPLETED**: There remains a considerable amount of work prior to project completion. Additional MCS tactical messages must be completed by 1St QTR 99 in order to meet the integration and test schedule. The TSIU segment must be completed and coordinated with DISA.

8. **SCHEDULES WITH MILESTONES**:

MILESTONES:



9. **POINT OF CONTACT**:

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FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

1. **PROJECT TITLE**: Evaluating the use of Combat Instruction Sets

2. **PROJECT ID**: SIM-98-TRADOC-01

3. **SPONSORING AGENCY**: TRADOC

4. **ACCOMPLISHMENTS**: A contract was awarded to Natural Selections, Inc, for the use of evolutionary programming in evaluating changing tactics in a varying scenario. Natural Selections has agreed to use the Eagle simulation as a test bed for aggregate level tactics. Natural Selection has shown this capability in an entity level simulation (ModSAF).

5. **LESSONS LEARNED:** Many of today's tactics, as defined in Combat Instruction Sets, are no longer completely valid as written. Changing scenarios and missions must be rapidly evaluated and we must have the capability to use these tactics in our training and analytical simulations.

6. **BENEFITS TO ARMY**: The training and analytical community will benefit from this methodology.

7. **WORK REMAINING TO BE COMPLETED**: The contractor will complete his analysis of evolutionary programming in aggregate level tactics and demonstrate this capability. He will submit a final report concerning lessons learned and how the tactics evolved from a given baseline.

8. **SCHEDULES WITH MILESTONES**: Final report due 28 February 1999.

9. **POINT OF CONTACT**: Ms. Pamela Blechinger
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FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

1. **PROJECT TITLE**: Multi-Paradigm Command Decision Modeling Architecture

2. **PROJECT ID**: SIM-98-TRADOC-02

3. **SPONSORING AGENCY**: TRADOC

4. **ACCOMPLISHMENTS**: The intent of this effort was to examine the technical issues and challenges associated with developing a multi-paradigm command decision modeling architecture spanning higher echelons of command. As part of this effort, we were able to establish multi-paradigm command decision modeling testbeds at JPL/NASA and the NSC. The SIMTECH program funded the JPL/NASA testbed effort. The JPL/NASA effort established a testbed environment for experimentation with OPFOR automation concepts while the NSC WARSIM Testbed efforts focused on the creation of BLUFOR multi-paradigm command entities.

5. This effort has made use of the command agent architecture that was developed during the 2nd US/United Kingdom CDM Workshop hosted on behalf of the DUSA(OR) in December 1996. The effort also examined the implementation of a Command Decision Modeling (CDM) prototype that employs a two-phase approach of (1) situation assessment and (2) option assessment to provide a course of action based on goals/objectives.

   We chose the two-phased approach to closely model the military paradigm of a commander and his staff. The staff analyzes and interprets battlefield processes with specialized expert knowledge and current situation information and provides the resulting synthesized information to their commander so that he or she does not have to process large amounts of information. We will review and utilize intelligent agent techniques applied in industry to model this relationship. We in the NSC portion of the testbed are beginning to design multiple advisor agents which will perform situation assessment and provide estimates of the situation to a command agent which will choose course(s) of action based on its knowledge base and objectives.

   The intent of this style architecture is to allow for the implementation of multiple advisor agents which use artificial intelligence techniques appropriate for their knowledge source(s) and a command agent which uses a knowledge based technique such as an expert system with a blackboard architecture. The interfaces between the advisor agents and the command agents are of a generic design to support the inclusion of additional advisor agents or the replacement of implemented advisors. An ability to interactively view/add/update goals and provide explanations for the courses of action chosen is planned.

   We reviewed existing CFOR/CCSIL software and as part of the JPL/NASA portion of the testbed we chose to reuse the CFOR CCSIL message parsing software as part of our orders input capability to the simulation.

   As far as the value of the product we produced, we feel we achieved great progress in the objective of automating the activities of the enemy on the battlefield. At the 16 June 1998

demonstration to Director, NSC and Director, TRAC, participants validated this assertion by stating that our CDM efforts will not only significantly reduce the manual effort of inputting orders into a simulation from hours to minutes but will reduce manpower overhead during exercise events.

1. **LESSONS LEARNED:** The DISC4 Strategic and Advanced Computing Center provided the NSC WARSIM Testbed a software process development case tool called G2. We are currently developing our CDM prototypes with G2. It provides a core capability that allowed us as the subject matter experts to rapidly develop the foundation for our MACE simulation as well as the OPFOR command agent work produced under the NASA/JPL effort. G2 is capable of supporting multiple technology paradigms so that we have avoided the integration issues associated with using separate tool suites such as a neural network, rule based system, and fuzzy logic only to run into major problems in integrating the tools for a final product. The rapid prototyping capability of G2 allows us to "white board" our concepts in software so that we can share and examine our ideas with other agencies such as STRICOM for applicability to WARSIM 2000. Having now established the initial core JPL/NASA and NSC testbeds, we realized the capability to prototype concepts that provide invaluable insights for refinement of CDM concepts before we implement them on a large scale in programs such as WARSIM 2000, JSIMS, and JWARS. This has the potential to bring monetary and functionality dividends to simulation programs.

2. **BENEFITS TO ARMY**: The intent of this effort was to establish a base for growth and experimentation leading to the development of M&S community practices and standards in modeling the military decision making process. We hope to continue to use both testbeds for future experimentation. We are meeting with organizations such as CECOM, STRICOM, BCBL, DISC4, TRAC, TPIO-ABCS, DCSINT, DMSO and others to form collabrative relationships and establish a program of research that will help to mitigate some of the risk of developing automated units for programs such as WARSIM 2000, JSIMS, and JWARS. Additionally, the efforts from this program directly support the role player and controller reductions intended for simulations such as WARSIM 2000.

3. **WORK REMAINING TO BE COMPLETED**:

   NASA/JPL will participate in the 3rd US/UK Command Decision Modeling Workshop from 27 Jul 98 to 4 Aug 98.

   NASA/JPL will complete user documentation and will deliver the software produced to the NSC as the final task of this SIMTECH funded effort.

   We also are continuing our in-house MACE effort and will begin development of the additional command agents in accordance with our design documentation. We will also be developing a collaborative prototype at the 3rd US/UK CDM Workshop which will most likely use the MACE environment as a base.

4. **SCHEDULE WITH MILESTONES**:

FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

NASA/JPL will support the 3rd US/UK Command Decision Modeling Workshop in the United Kingdom with a presentation on Smart Enemy Agent efforts and a demonstration video of the working system.

We will be using our MACE environment as a basis for development of a collaborative prototype between the US and UK. This will be our first such effort and should stimulate the growth of the partnering relationship we are trying to establish with the UK.

NASA/JPL will deliver to the NSC, user documentation and software developed to support both the existing task and the additional US/UK workshop task in Aug 98.

5. **POINT OF CONTACT**:

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FY98 SIMTECH PROGRAM PROJECT STATUS REPORT

1. **PROJECT TITLE:** A Federate for Data Collection and Analysis (Analysis Federate)

2. **PROJECT ID:** SIM-98-TRADOC-03

3. **SPONSORING AGENCY:** TRADOC Analysis Center - Monterey, TRADOC

4. **ACCOMPLISHMENTS**: Significant progress has been made in completing the proposed research. The systems analysis and design are complete. An Analysis Federate prototype that implements this design has been developed, delivered, and tested.

   The Analysis Federate prototype and corresponding research provides general purpose reusable techniques and procedures that can be used to help automate the creation of federates, ease the programming burden associated with the implementation of a High Level Architecture (HLA) interfaces and services, and provide a methodology to facilitate the reuse of federates in federations that use different Federation Object Model (FOM). The technological solution focuses on developing a methodology that addresses the integration issues associated with subscribing to an arbitrary FOM for the purposes of building up a change-based historical database of object attribute changes and interactions.

   The Analysis Federate research provides the DoD with the capability to collect, process, generate, display, store, access, present, and transfer aggregate FOM data from distributed HLA simulations in order to conduct real-time or post-simulation analysis. The HLA Rules mandate that this prototype tool be implemented as a HLA federate because it will be used to collect, generate, and exchange FOM data during federation execution. This data collection and "Analysis Federate" must implement the HLA interfaces, invoke the HLA services, and be adaptable for use with any federation.

   The development and testing of the prototype was performed in HLA federation that included the Analysis Federate and two Janus simulations communicating with each other over a computer network. Janus HLA functionality was established by using two Protocol Data Unit (PDU) Adapter Software Systems (PASS) and two HLA Gateways. The PASS module translated internal Janus data into Distributed Interactive Simulation (DIS) PDUs. Then, the HLA Gateway translated the DIS PDUs into the data format specified by the Gateway's FOM.

   The merits of the analysis capabilities of the Analysis Federate prototype are described in a Naval Postgraduate School thesis that performs a comparison study of existing HLA and DIS distributed simulation analysis methodologies. [i] The thesis attempts to answer a set of analysis questions by fighting a Janus scenario over a computer network using different Advanced Distributed Simulation (ADS) techniques. The methodology available to analyze the Janus battle using DIS technology is compared to the methodologies available to analyze the same battle using HLA both with and without the Analysis Federate. It is important to note that the data that was available for analysis in the HLA battles was limited by the data

that is transmitted in DIS PDUs. This limitation will always exist when the Gateway is used to provide HLA functionality to DIS simulations.

The Analysis Federate research results have been presented in several public forums. These presentations generated considerable interest in the simulation community. The Analysis Federate's architecture and functionality were presented at the 9th French - American Seminar on Operations Research. [ii] The Analysis Federate's implementation techniques were presented and the prototype was demonstrated at the 66th Military Operations Research Society Symposium as part of the presentation titled "A General Purpose Solution for Analysis in the High Level Architecture." A detailed discussion of the Analysis Federate architecture, research contributions, and its impact on analysis in HLA was presented at the June 1998 Simulation Interoperability Standards Organization (SISO) Analysis Forum Interim Meeting. [iii] The research contributions that are developed in this research project will be presented and published in September at the 1998 Fall Simulation Interoperability Workshop in a paper titled "Analysis Federate."

The composability of the Analysis Federate across federations was demonstrated when the Analysis Federate was integrated into the Army's Eagle-MODSAF federation. The Analysis Federate will be used to perform analysis in this federation as part of TRADOC's Army Experiment 5 technology demonstration.

5. **LESSONS LEARNED**: This Analysis Federate research does not satisfy all analysis needs in HLA. Instead, four additional research areas need emphasis in order to provide the analyst with a truly composable approach to analysis in HLA. These four research areas are described in detail in four separate follow on SIMTECH and AMIP proposals and are not detailed in this project status reports.

   Implementation of the integrated technological solution described in this research produced several research contributions. Each of these contributions was used in developing the Analysis Federate prototype.

   The first research contribution improves interoperability in distributed HLA simulations by developing a methodology that makes it feasible to extend the existing concept of federates being composable components within a unique federation that uses a specific FOM, to the new concept of federates being composable components of multiple federations that use different FOMs. This new concept of federate composability across federations does not eliminate the requirement for a federate to comply with the HLA rules. Therefore, a unique SOM must be developed for each federation the federate will join. This research contribution includes provisions that enable this SOM generation to be automated.

   The second research contribution improves interoperability in HLA by developing a methodology that makes it feasible to eliminate the existing need to write the FOM specific computer code necessary to invoke HLA subscription and publication services from within a federate. This methodology required development of an application program tool that is composable and reusable with any FOM. This application program streamlines both the

development of new HLA federates, and the conversion of conventional models and simulations into HLA federates by providing the ability to dynamically subscribe and publish without writing code.

The third research contribution improves interoperability in HLA by developing a methodology that makes it feasible to provide currently non-existent data marshalling capabilities to federates. This enables federates to: check, during federation execution, if RTI packets are the "right" size as specified by the FOM; and to identify, during federation execution, federates that violate published FOM data structure standards.

The fourth research contribution can be considered as an enabling technology for the first three contributions. The successful development and implementation of the above research contributions all required the development of a method to automatically represent the federation's data structure standards in computer memory during federation execution. This required an innovative solution approach because the HLA uses byte streams to transfer object and interaction data between federates. The architecture does not provide a mechanism to access data type information during federation execution. However, this was accomplished by having all components of the federation's object model available at run time.

6. **BENEFITS TO ARMY**: The Analysis Federate research enables the user to collect, store, and perform analysis on the aggregate data from distributed HLA simulations. It can be used to perform real-time data collection and either real-time or post-exercise analysis. The benefits to the DoD associated with the functionality include the ability to: answer analysis questions in HLA simulations; provide immediate real time feedback; help exploit situational awareness; improve mission planning and rehearsal; assist in course of action analysis; improve the quality and timeliness of after action reviews; facilitate distance learning; enhance emerging live, virtual, constructive, and synthetic theater of war (STOW) training support systems; and support fielding of the digitized division in the Army.

   The tools and methodology developed in this research can be used to improve interoperability in HLA federations by providing the technology necessary to begin to treat federates as composable components across multiple federations. These tools and methodologies can be used to eliminate the need for federate developers to write code to implement RTI services, and the need to modify federate's local RTI component code in response to FOM changes. The tools can also be used to minimize the work needed to map federation data into a federate's internal data representation by substituting a mapping file for computer code and by allowing the use of the federation's data structures in the file instead of the RTI byte streams that are used by programmers. Another potential use for these tools is to streamline both the development of new HLA federates, and the conversion of conventional models and simulations into HLA federates.

7. **WORK REMAINING TO BE COMPLETED**: The Analysis Federate approach to data collection differs from existing data collection and analysis procedures that operate under the premise that all possible data is collected at the source and assembled for replay and

presentation. Instead, the Analysis Federate approach promotes the collection of only the data that is required to answer the specified analysis questions. The research that focuses on formalizing the methods needed to identify the data that must be collected in order to answer specific analysis questions is not completed. These formal methods are termed the Study Question Methodology.

8. **SCHEDULES WITH MILESTONES**: The Study Question Methodology will be formalized and the final report that will be delivered in July 1999

9. **POINT OF CONTACT**:

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[i] Knight, Steven D., "A Comparison of Analysis in DIS and HLA," Naval Postgraduate School, Thesis, Monterey, California, June 1998.

[ii] Murphy, William S., Jr., "HLA Federate for Data Collection and Analysis" a briefing at the 9th French American Seminar on Operations Research, Paris, France, May 1998.

[iii] Murphy, William S., Jr., "A Composable Analysis Federate," a briefing at the Simulation Interoperability Standards Organization (SISO) Analysis Forum Interim Meeting, Monterey, California, June 1998.

GLOSSARY

Section I – Abbreviations

AAE
Army Acquisition Executive

AAN
Army After Next

ABCS
Army Battle Command System

ACAT
Acquisition Category

ACR
Advanced Concepts and Requirements

ACT
Advanced Concept and Technology

ADCSOPS
Assistant Deputy Chief of Staff for Operations and Plans

ADE
Army Data Encyclopedia

ADO
Army Digitization Office

ADS
Advanced Distributed Simulation

AEA
Army Enterprise Architecture

AFOR
Automated Forces

AIM
Atmospheric Illumination Module

AIMSSS
Army Information on Models, Simulations, and Studies System

AI
Artificial Intelligence

AIS
Automated Information System

ALSP
Aggregate Level Simulation Protocol

AMC
U.S. Army Materiel Command

AMCOM
US Army Aviation and Missile Command

AMG
Architecture Management Group

AMIP
Army Model Improvement Program

AMS GOSC
Army Model and Simulation General Officer Steering Committee

AMSAA
Army Materiel Systems Analysis Activity

AMSEC
Army Model and Simulation Executive Council

AMSMP
Army Model and Simulation Management Program

AMSMP WG
Army Model and Simulation Management Program Working Group

AMSO
Army Model and Simulation Office

AMSTR
Army Model and Simulation Technology Review

ANL
Argonne National Lab

AP
Adversarial Planner

AR
Army Regulation

ARES
Advanced Regional Exploratory System

ARI
U.S. Army Research Institute for Behavioral and Social Sciences

ARL
Army Research Lab

ASA(FM&C)
Assistant Secretary of Army for Financial Management and Comptroller

ASA (M&RA)
Assistant Secretary of the Army (Manpower and Reserve Affairs)

ASA(RDA)
Assistant Secretary of Army for Research, Development, and Acquisition

ASTARS
Army Standards Repository System

ASWG
Advanced Simulation Working Group

ATC
Aberdeen Test Center

ATCAL
Attrition Calibration Model

ATD
Advanced Technology Demonstration

AV 2010
Army Vision 2010

AWARS
Army Warfare System

AWC
U.S. Army War College

AWE
Advanced Warfighting Experiment

BASOP
Base Operations

BCBL
Battle Command Battle Lab

BLITS
Boundary Layer Illumination and Transmission Simulation

BLUFOR
Blue Forces

BML
Battle Management Language

C4I
Command, Control, Communications, Computers and Intelligence

C4ISR
Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissanc

CAA
U.S. Army Concepts Analysis Agency

CAIV
Cost as an Independent Variable

CASCOM
Combined Arms Support Command

CASTFOREM
Combined Arms and Support Task Force Evaluation Model

CASE
Computer Aided Software Engineering

CCSIL
Command and Control Simulation Interface Language

CCTT SAF
Close Combat Tactical Trainer Semi-Automated Forces

CDAd
Component Data Administrator

CDM
Command Decision Modeling

CEAC
Cost and Economic Analysis Center

CECOM
US Army Communications and Electronics Command

CEM
Concepts Evaluation Model

CFOR
Command Forces

CG
Commanding General

CG, TRADOC
Commanding General, U.S. Army Training and Doctrine Command

CGF
Computer Generated Forces

CINC
Commander-in-Chief

CITM
Coastal Inter-Modal Transport Model

CM
Configuration Management

COB
Command Operating Budget

COE
Common Operating Environment

COTS
Commercial Off-The-Shelf

CONUS
Continental United States

COSAGE
Combat Sample Generator

C&P
Characteristics and Performance

CRREL
Cold Regions Research Engineering Lab

CRTC
Cold Regions Test Center

CSA
Chief of Staff of the Army

CSS
Combat Service Support

CSSM
Cloud Scene Simulation Model

DA
Department of the Army

DAB
Defense Acquisition Board

DAC
Department of the Army Civilian

DARPA
Defense Advanced Research Projects Agency

DAS (R&T)
Deputy Assistant Secretary for Research and Technology

DCG
Deputy Commanding General

DCSINT
Deputy Chief of Staff for Intelligence

DCSLOG
Deputy Chief of Staff for Logistics

DCSOPS
Deputy Chief of Staff for Operations and Plans

DCSPER
Deputy Chief of Staff for Personnel

DCSSA
Deputy Chief of Staff for Simulations and Analysis

DDL
Delegation of Disclosure Letter

DDDS
Defense Data Dictionary System

DDRS
Defense Data Repository System

DEA
Data Exchange Agreement

DII
Defense Information Infrastructure

DII COE
Defense Information Infrastructure Common Operating Environment

DIF
Database Interchange Format

DIS
Distributed Interactive Simulation

DISA
Defense Information Systems Agency

DISC4
Director of Information Systems for Command, Control, Communications, and Computers

DISN
Defense Integrated Services Network

DMSO
Defense Modeling and Simulation Office

DMSTTIAC
Defense Modeling, Simulation, and Tactical Technology Information and Analysis Center

DoD
Department of Defense

DPRB
Defense Planning and Resources Board

DSI
Defense Simulation Internet

DTD
Digital Topographic Data

DUSA (IA)
Deputy Under Secretary of the Army for International Affairs

DUSA(OR)
Deputy Under Secretary of Army for Operations Research

E-OP
Engineering Operations

EUSA
Eighth U.S. Army

EXCIMS
Executive Council for Modeling and Simulation

FBCB2
Force XXI Battle Command Brigade and Below

FDB
Functional Description of the Battlespace

FFRDC
Federally Funded Research and Development Center

FMS
Foreign Military Sales

FOA
Field Operating Agency

FOM
Federation Object Model

FORSCOM
U.S. Army Forces Command

FTP
File Transfer Protocol

FTSS
Flight Test Simulation Station

FY
Fiscal Year

GIS
Geographical Information Systems

GO
General Officer

GOSC
General Officer Steering Committee

GS
General Schedule

GUI
Graphical User Interface

HLA
High Level Architecture

HOL
High Order Language

HQDA
Headquarters, Department of Army

IA
International Agreement

IAW
In Accordance With

ICT
Integrated Concept Team

IDEF
Integrated Definition Language

IEA
International Exchange Agreement

IEEE
Institute of Electrical and Electronic Engineers

IET21
Intelligent and Emerging Technology

IMA – Individual Mobilization Augmentee

IPR
In-Process Review

IR
Infrared

IV&V
Independent Verification and Validation

JMASS
Joint Modeling and Simulation System

JPL
Jet Propulsion Lab

JROC
Joint Requirements Oversight Council

JSIMS
Joint Simulation System

JTA
Joint Technical Architecture

JTA - Army
Joint Technical Architecture - Army (formerly the Army Technical Architecture (ATA))

JWARS
Joint Warfare System

KQML
Knowledge Query Manipulation Language

LDB
Logistics Description of the Battlespace

LOA
Letter of Agreement

LOS
Line of Sight

MACE
Military Art of Command Environment

MACOM
Major Army Command

MAIS
Major Automated Information Systems

MAISRC
Major Automated Information Systems Review Council

MAP
Mandatory Procedures for Major Defense Acquisition Programs

MCS
Maneuver Control System

MDA
Milestone Decision Authority

MDEP
Management Decision Package

MICOM
US Army Missile Command

M&S
Model(s) and Simulation(s) - Used in singular and plural

MNS
Mission Needs Statement

MOA
Memorandum of Agreement

ModSAF
Modular Semi-Automated Forces

MODTRAN
Moderate Transmission Model

MOEs
Measures of Effectiveness

MOPs
Measures of Performance

MOOTW
Military Operations Other Than War

MRDEC
Missile Research, Development, and Engineering Center

MRM
Multi-Resolution Modeling

MSEA
M&S Executive Agent

MSIS
Model and Simulation Information System

MSOSA
Modeling and Simulation Operational Support Activity

MSRD
Model and Simulation Requirements Document

MSRR
Model and Simulation Resource Repository

MTMC
Military Traffic Management Command

MTW
Major Theater of War

MTMCTEA
Military Traffic Management Command Transportation Engineering Agency

NASA
National Aeronautics and Space Agency

NGB
National Guard Bureau

NGIC
National Ground Intelligence Center

NIMA
National Imagery and Mapping Agency

NPR
National Performance Review

NSC
National Simulation Center

NSTD
Non-System Training Device

OA
Operational Architecture

OCAR
Office of the Chief, Army Reserve

OCONUS
Outside Continental United States

OGC
Office of the General Counsel

OMA
Operations and Maintenance, Army

OMSC
Object Management Steering Committee

OMT
Object Model Template

OneSAF
One Semi-Automated Force

OPA
Other Procurement, Army

OPFOR
Opposing Forces

OPNET
Operational Network

OPTEC
U.S. Army Operational Test and Evaluation Command

ORD
Operational Requirements Document

OSA
Office of Secretary of the Army

OSD
Office of the Secretary of Defense

P&A
Price and Availability

PAED
Army Program Analysis and Evaluation Directorate

PAO
Public Affairs Office(r)

PASS
PDU Adapter Software Systems

PBD
Program Budget Decision

PC
Personal Computer

P(det)
Probability of Detection

PDU
Protocol Data Unit

PEG
Program Evaluation Group

PEO
Program Executive Officer

P(los)
Probability of Line of Sight

PM
Program Manager

POC
Point of Contact

POM
Program Objective Memorandum

PORTSIM
Port Simulation Model

PPBES
Planning, Programming, Budgeting, and Execution System

PPBS
Planning, Programming, and Budgeting System

QA
Quality Assurance

R2R
Resources to Readiness

R&D
Research and Development

RDA
Research, Development, and Acquisition

RDT&E
Research, Development, Test and Evaluation

RFP
Request for Proposal

RFPI
Rapid Force Projection Initiative

RIA
Requirements Integration and Approval

RIC
Requirements Integration Council

RIWG
Requirements Integration Working Group

RTI
Runtime Infrastructure

RULST
Route and Landmark Selection Tool

S&T
Science and Technology

SABRE
Single Army Battlefield Requirements Evaluator

SACC
Strategic and Advanced Computing Center

SAF
Semi-Automated Force

SAI
Subject Area Information

SAMSO
Standard Army Model and Simulation Objects

SBA
Simulation Based Acquisition

SC
Standard Category

SCC
Standards Category Coordinator

SEDRE
Sealift Emergency Deployment Readiness Exercise

SEDRIS
Synthetic Environment Data Representation and Interchange Specification

SES
Senior Executive Service

SIG
Special Interest Group

SIGCEN
US Army Signal Center

SimPaths II
Comparative Simulation State and Path Research/Interpretation

SIMTECH
Simulation and Technology Program

SIPRNet
Secret Internet Protocol Routing Network

SMART
Subject Matter Analysis Retrieval Tool

SMDBL
Space and Missile Defense Battle Lab

SMDC
U.S. Army Space and Missile Defense Command

SNAP
Standards Nomination and Approval Process

SNTHERM
Snow Melt Thermal Model

SOM
Simulation Object Model

SOW
Statement of Work

SQL
Standard Query Language

SRD
Standards Requirement Document

SSA
Staff Support Agency

SSE
Simulation Support Environments

SSEAMS
Simulation Support Environments for Army Model & Simulation

SSP
Simulation Support Plan

STAMIS
Standard Management Information System

STEQR
Synthetic Environment Quarterly Review

STOW
Synthetic Theater of War

STORM-VS
Simulation Testing Operations Rehearsal Model – Visualization System

STOW-A
Synthetic Theater of War-Architecture

STRICOM
Simulation, Training, and Instrumentation Command

T&E
Test and Evaluation

TAFIM
Technical Architecture Framework for Information Management

TEA
Transportation Engineering Agency

TEC
Topographic Engineering Center

TECOM
US Army Test & Evaluation Command

TEMO
Training Exercises and Military Operations

Three (3)-D
3 Dimensional Visualization

TOC
Tactical Operations Center

TP
TRADOC Pamphlet

TPA
Technology Program Annex

TPO
Technical Project Officer

TPIO-ABCS
TRADOC Project Integration Office Army Battle Command System

TRAC
TRADOC Analysis Center

TRAC-FLVN
TRADOC Analysis Center, Fort Leavenworth

TRAC-WSMR
TRADOC Analysis Center, White Sands Missile Range

TRADOC
U.S. Army Training and Doctrine Command

TRANSCOM
U.S. Transportation Command

TSIU
Tactical Simulation Interface Unit

TTC
Tropic Test Center

UMD
Unit Model Diagrams

URL
Universal Resource Location

USACAA
U.S. Army Concepts Analysis Agency

USACE
U.S. Army Corps of Engineers

USAREUR
U.S. Army Europe

USARPAC
U.S. Army Pacific

USARSO
U.S. Army South

USASAC
U.S. Army Security Assistance Command

USASOC
U.S. Army Special Operations Command

US/UK CDM
United States/United Kingdom Command Decision Modeling

UVA
University of Virginia

VCSA
Vice Chief of Staff of the Army

VEDS
Virtual Environments Database Server

VIC
Vector In Command

VIC-EFAM
VIC Engineer Functional Area Model

VPG
Virtual Proving Ground

V&V
Verification and Validation

VV&A
Verification, Validation, and Accreditation

VV&C
Verification, Validation, and Certification

WARSIM 2000
Warfighter Simulation 2000

WES
Waterways Experiment Station

Windows NT
Windows New Technology

WG
Working Group

WWW
World Wide Web

Section II - Terms

Accreditation
The official determination that a model, simulation, or federation of M&S is acceptable for use for a specific purpose.

Accreditation Agent
The organization designated by the application sponsor to conduct an accreditation assessment for a M&S application.

Accreditation Criteria
A set of standards that a particular model, simulation, or federation of M&S must meet to be accredited for a specific purpose.

Advanced Concepts and Requirements (ACR) Domain
One of the three domains for Army M&S applications. ACR includes experiments with new concepts and advanced technologies to develop requirements in doctrine, training, leader development, organizations, materiel and soldiers which will better prepare the Army for future operations. ACR evaluates the impact of horizontal technology integration through simulation and experimentation using real soldiers in real units.

Advanced Distributed Simulation (ADS)
A set of disparate M&S operating in a common synthetic environment within which humans may interact at multiple sites networked using compliant architecture, modeling, protocols, standards, and data bases. The ADS may be composed of three modes of simulation-- live, virtual, and constructive which can be seamlessly integrated.

Analysis
A broad category of study and investigation which includes support to operational, tactical, and strategic decision making.

Analysis of Alternatives
A study conducted to provide support for acquisition decisions in the acquisition cycle. The AoA illuminates the relative advantages and disadvantages of the alternatives being considered showing the sensitivity of each alternative to possible changes in key assumptions (e.g., threat) or variables (e.g., performance capabilities). There shall be a clear linkage between the AoA, system requirements, and system evaluation measures of effectiveness.

Application
A specific, individual project session that requires or uses an M&S to achieve its purpose.

Application Sponsor
The organization that utilizes the results or products from a specific application of a model or simulation.

Architecture
The structure of components in a program/system, their relationships, and the principles and guidelines governing their design and evolution over time.

Army Enterprise Architecture (AEA) Master Plan
An integrated plan of action for accomplishing Army-wide information technology and investment strategies to accomplish the Joint Vision and the Army Vision 2010. It documents the total AEA and specifies the information systems programs and resource requirements necessary to support stated sessions and objectives.

Army Model and Simulation Standards Report
The Army Model and Simulation Standards Report contains the yearly status of Army efforts to standardize model and simulation techniques and procedures. It also reflects the Army's yearly model and simulations investments throughout the Army Model Improvement Program (AMIP) and the Simulation Technology (SIMTECH) Program.

Automated Information System (AIS)
A combination of information, computer hardware, software, personnel, and telecommunications resources that collects, records, processes, stores, communicates, retrieves, and/or displays information.

Common Use M&S
M&S applications, services, or materials provided by a DoD Component to two or more DoD components.

Computer Generated Forces
A capability/technology where computer generated forces are a doctrinally correct representation of both friendly and opposing forces. These forces will support simulations by providing opposing forces, supporting forces, and forces needed to permit a smaller number of personnel to represent a much larger force.

Configuration Management
The application of technical and administrative direction and surveillance to identify and document the functional and physical characteristics of a M&S, control changes, and record and report change processing and implementation status.

Constructive M&S
M&S that involve real people making inputs into a simulation that carries out those inputs by simulated

people operating simulated systems.

Data Certification
The determination that data have been verified and validated. Data user certification is the determination by the application sponsor or designated agent that data have been verified and validated as appropriate for the specific M&S usage. Data producer certification is the determination by the data producer that data have been verified and validated against documented standards or criteria.

Data Exchange Standard
Formally defined protocols for the format and content of data messages used for interchanging data between networked simulation and/or simulator nodes used to create and operate a distributed, time and space coherent synthetic environment. Current standards include ALSP and DIS Protocol Data Units.

Data Proponent
The agency or organization that has primary responsibility for a Data collection or data base. The proponent develops the requirement for the data.

Data Standards
A capability that increases information sharing effectiveness by establishing standardization of data elements, data base construction, accessibility procedures, system communication, data maintenance and control.

Data Validation
The documented assessment of data by subject area experts and its comparison to known values. Data user validation is an assessment as appropriate for use in an intended M&S. Data producer validation is an assessment within stated criteria and assumptions.

Data Verification
Data producer verification is the use of techniques and procedures to ensure that data meets constraints defined by data standards and business rules derived from process and data modeling. Data user verification is the use of techniques and procedures to ensure that data meets user specified constraints defined by data standards and business rules derived from process and data modeling, and that data are transformed and formatted properly.

Defense Simulation Internet (DSI)
A wide band telecommunications network operated over commercial lines with connectivity to both military and civilian satellites allowing users to be linked on a world-wide, wide area network.

Distributed Interactive Simulation (DIS)
A subset of advanced distributed simulation which interfaces through the use of DIS Protocol Data Units.

DIS Compatible
Two or more simulations/simulators are DIS compatible if (1) they are DIS compliant and (2) their models and data that send and interpret protocol data units support the realization of a common operational environment among the systems (coherent in time and space).

DIS Compliant
A simulation/simulator is DIS compliant if it can send and receive protocol data units in accordance with IEEE Standard 1278 and 1278 (Working Drafts). A specific statement must be made regarding the qualifications of each protocol data unit.

Dynamic Environment
The environment is constantly changing as a result of man-made efforts (battlefield smoke) and natural phenomenon (weather). Incorporating dynamic environment into real time simulations provides a more realistic test bed for weapons, equipment, and personnel.

Emulator
A physical M&S which duplicates the behavior, properties, or performance of another system. Emulators are frequently used to generate inputs for other M&S.

Fair Fight
Two or more simulations may be considered to be in a fair fight when differences in the simulations' performance characteristics have significantly less effect on the outcome of the conflict than actions taken by the simulation participants.

Federation Element
Term applied to an individual M&S that is part of a federation of models and simulations. Federation elements may be distributed.

Federation of Models and Simulations
A system of interacting M&S with supporting infrastructure, based on a common understanding of the objects portrayed in the system.

Firmware
The combination of a hardware device and computer instructions or computer data that reside as read-only software on the hardware device. The software cannot be readily modified under program control.

General-use M&S Applications
Specific representations of the physical environment or environmental effects used by, or common to, many M&S (e.g., terrain, atmospheric, or hydrographic effects).

High Level Architecture
Major functional elements, interfaces, and design rules, pertaining, as feasible, to all DoD simulation applications, and providing a common framework within which specific system architectures can be defined.

Independent Verification and Validation (IV&V)
The conduct of verification and validation of M&S by individuals or agencies that did not develop the M&S. IV&V does not require complete organizational independence, but does imply a reasonable degree of organizational separation to assure unbiased analysis.

Interoperability
The ability of a set of M&S to provide services to and accept services from other M&S and to use the services so exchanged to enable them to operate effectively together.

Live Simulation
A representation of military operations using live forces and instrumented weapon systems interacting on training, test, and exercise ranges which simulate experiences during actual operational conditions.

Management threshold
The threshold or limit, as defined by management, when a M&S passes from the management considerations of one category or level to the management considerations of another category.

Model
A model is a physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process.

Model Types
a. Physical model. A physical representation of the real world object as it relates to symbolic models in the form of simulators.
b. Mathematical model. A series of mathematical equations or relationships that can be discretely solved. This includes M&S using techniques of numerical approximation to solve complex mathematical functions for which specific values cannot be derived (e.g., integrals).
c. Procedural model. An expression of dynamic relationships of a situation expressed by mathematical and logical processes. These models are commonly referred to as simulations.

M&S Developer
The organization responsible for developing, managing or overseeing M&S developed by a DoD component, contractor, or Federally Funded Research and Development Center. The developer may be the same agency as the proponent agency.

M&S Activity
The development and maintenance of a computer-based M&S capability by or for organizations of the U.S. Army.

M&S Proponent
The organization responsible for initiating the development and directing control of the reference version of a model or simulation. The proponent will develop and execute a viable strategy for development and maintenance throughout the life cycle of the M&S; and for directing the investment of available resources in same. The M&S proponent serves as the advocate and final authority on their M&S. The proponent will advise the DUSA(OR) on release of the M&S to foreign countries, and will advise the MACOM or Organizational Release Authority for domestic release. Except where responsibilities are specifically designated to an acquisition official by DoD or DA policy e.g. DoD 5000.2 or AR 70-1, the M&S proponent is responsible for, but may delegate execution of: M&S Development; Configuration Management; Preparation and Maintenance of Simulation Object Models (SOMs) as appropriate; all aspects of Verification and Validation; and maintenance of current information in all catalogs and repositories.

Modeling and Simulation
The development and use of live, virtual, and constructive models including simulators, stimulators, emulators, and prototypes to investigate, understand, or provide experiential stimulus to either (1) conceptual systems that do not exist or (2) real life systems which cannot accept experimentation or observation because of resource, range, security, or safety limitations. This investigation and understanding in a synthetic environment will support decisions in the domains of research, development, and acquisition (RDA) and advanced concepts and requirements (ACR), or transfer necessary experiential effects in the training, exercises, and military operations (TEMO) domain.

Non-System Training Device (NSTD)
A training device or simulation which is not directly identified with a unique weapons system, but rather has application over a wide spectrum of potential users (e.g., WARSIM). The NSTD process is

governed by the AR 70 series.

Open Systems Environment
The fielding of hardware and software products that are interoperable and portable. The objective is to promote competition by allowing systems developed by multiple vendors and nations to interoperate through a common set of computer and communications protocols.

Pre-Processor
A software (and sometimes hardware) unit which conditions or prepares data before the data is input into a model or simulation. Example: A code which converts metric data from cartesian (rectangular) coordinates to flight coordinates (Euler angles) prior to its being input into an aircraft or guided missile model.

Post Processor
A software (and sometime hardware) unit which conditions data after it is output by a model or simulation, in order to adapt it to a human analyst/observer or to another model. Example: A code which converts streams of metric measurement data from a simulation into a graphic representation of a scene as viewed from the perspective of an aircraft or missile.

Proponent
See M&S Proponent or Data Proponent

Protocol Data Unit (PDU) Standards
In accordance with IEEE Standard 1278, formally defined data exchange standards established for each of the several primary classes of functionality which is represented in the DIS synthetic environment (e. g. movement, weapons, firing effects, collisions, etc.).

Reference Version
The most recent version of a M&S which has been released for community use by, and under configuration management of, the M&S users group executive committee.

Research, Development, and Acquisition (RDA) Domain
One of the three domains for Army M&S applications. Includes all M&S used for design, development, and acquisition of weapons systems and equipment. M&S in the RDA domain are used for scientific inquiry to discover or revise facts and theories of phenomena, followed by transformation of these discoveries into physical representations. RDA also includes test and evaluation (T&E) where M&S are used to augment and possibly reduce the scope of real-world T&E.

Simulation
A method for implementing a model(s) over time.

Simulator
a. A device, computer program, or system that performs simulation.
b. For training, a device which duplicates the essential features of a task situation and provides for direct practice.
c. For Distributed Interactive Simulation (DIS), a physical model or simulation of a weapons system, set of weapon systems, or piece of equipment which represents some major aspects of the equipment's operation.

Sponsoring Agency
The agency which sponsors the development or use of M&S utilizing either in-house, other government agency, or contract resources.

Standard
A rule, principle, or measurement established by authority, custom, or general consent as a representation or example.

Standards Categories
The elements of the framework for M&S standards development. The Standards framework contains all the things the Army M&S community seeks to represent algorithmically, devolved into Categories which are assigned to the Army agencies best suited to coordinate development and maintenance of standards in the technical regime represented by that category.

Stimulator
a. A hardware device that injects or radiates signals into the sensor system(s) of operational equipment to imitate the effects of platforms, munitions, and environment that are not physically present.
b. A battlefield entity consisting of hardware and/or software modules which injects signals directly into the sensor systems of an actual battlefield entity to simulate other battlefield entities in the virtual battlefield.

Symbolic M&S
M&S which represent a real system using mathematical equations or computer programs. Symbolic M&S are contrasted from other representations such as maps, board games, field exercises, and mockups.

Synthetic Environments (SE)
Internetted simulations that represent activities at a high level of realism from simulations of theaters of war to factories and manufacturing processes. These environments may be created within a single

computer or a vast distributed network connected by local and wide area networks and augmented by super-realistic special effects and accurate behavioral models. They allow visualization of and immersion into the environment being simulated. (Ref. DoD 5000.59-P; CJSI 8510.01)

Technical Architecture
A minimal set of rules governing the arrangement, interaction, and interdependence of the parts or elements that together may be used to form an information system, and whose purpose is to insure that a conformant system satisfies a specified set of requirements.

Test and Evaluation (T&E)
Test and evaluation includes engineering, developmental, and operational tests.

Training Effectiveness Analysis (TEA)
A study conducted by TRADOC Analysis Center (TRAC) to determine the adequacy of the operator, maintainer, unit, and institutional training for new equipment which is fielded. TEAs evaluate training environment, training devices, soldier hardware-software interface, and military occupational specialty selection criteria.

Training, Exercises, and Military Operations (TEMO) Domain
One of the three domains for Army M&S applications. TEMO includes most forms of training at echelons from individual simulation trainers through collective, combined arms, joint, and/or combined exercises. TEMO includes mission rehearsals and evaluations of all phases of war plans. Analysis conducted during the rehearsal or evaluation validates the plan as best as the simulation environment will allow.

Validation
The process of determining the extent to which a M&S is an accurate representation of the real-world from the perspective of the intended use of the M&S. Validation methods include expert consensus, comparison with historical results, comparison with test data, peer review, and independent review.

Validation Agent
The organization designated by the M&S sponsor to perform validation of a model, simulation, or federation of M&S.

Verification
The process of determining that a M&S accurately represents the developer's conceptual description and specifications. Verification evaluates the extent to which the M&S has been developed using sound and established software engineering techniques.

Verification Agent
The organization designated by the M&S sponsor to perform verification of a model, simulation, or federation of M&S.

V&V Agent
The organization designated by the M&S sponsor to perform verification and validation of a model, simulation, or federation of M&S.

V&V Proponent
The government agency responsible for ensuring V&V is performed on a specific M&S.

Virtual M&S
A synthetic representation of warfighting environments patterned after the simulated organization, operations, and equipment of actual military units.